WHAT IS CONDENSERY MILK WORTH?

A. C. ANDERSON

Michigan Agricultural College, East Lansing, Michigan

During the period of evolution of the factory system for the manufacture of dairy products in this country, it became customary in making payments for raw material to allot to each milk patron such portion of the net returns from the enterprise as the weight of the milk which he had delivered sustained to the aggregate quantity of milk delivered by all the patrons.

While this method of payment was rather crude it attempted commercial equity in two ways—first, by giving each producer of milk his proportionate share; and second, by having the price paid for milk governed in considerable degree by the selling price of the manufactured product. The development of the Babcock test, the adoption of legal standards for butter and cheese, and the general use of approved methods of factory technique have so standardized the manufacture of butter and cheese that the amount of milk of a known test which would be required to produce a given quantity of either butter or cheese is a matter of quite general knowledge. Further by consulting the current market quotations one would be able to assign a pretty definite farm value to the milk or its butter fat content. Cream for butter making or milk for cheese making have come to have as definitely quotable market values as have live stock or the cereal grains sold from the farm; and the proportionate shares of such prices which should be due the farmer for his product either at the factory or the shipping station is a matter of common knowledge.

While the prices for milk to be used in butter and cheese manufacture may in a broad sense be said to have reached an equitable basis, the prices for milk used in some other lines of dairy

TABLE 1

DATE	SCHEDULE OF MILK PRICES PAID BY CONDENSING COMPANY M AT FACTORY K FOR THE PERIOD APRIL 1, 1915, TO SEPTEMBER 30, 1917													PRICE ALLOWED PER POUND FOR THE BUTTER FAT CONTENT OF THE MILK PURCHASED	PRICE ALLOWED FOR THE SOLIDS, NOT FAT CONTENT, IN EACH 100 POUNDS OF THE MILK PURCHASED	AVERAGE PRICE PAID PER POUND BY CREAMERIES FOR BUTTERFAT CONTAINED IN SOUR CREAM DURING EACH MONTH OF THE PERIOD COVERED (ELGIN PLUS 1 CENT)	VALUE OF SWEET CREAM FROM 100 POUNDS OF 3.5 PER CENT MILK AT 8 CENTS NET ABOVE ELGIN	AMOUNT PAID FOR 85 POUNDS OF SKIMMED MILK, OR ALLOWANCE FOR THE SOLIDS NOT FAT CONTENT OF THE MILK PURCHASED	SELLING PRICE TO JOBBERS OF 48-POUND CASE OF X BRAND CONDENSED MILK	PRICE WHICH COULD HAVE BEEN PAID FOR 100 POUNDS OF 3.5 PER CENT MILK BASED ON COST OF MANUFACTURE AND DELIVERY PLUS 10 PER CENT PROFIT.	ACTUALLY PAID PER HUNDREDWEIGHT OF 3.5 PER CENT MILK
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2 AND OVER							
1915																				
April	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.56	1.59	$0.30	$0.33	$0.30½	$1.31	$0.07	$5.65	$2.15	$1.38
May	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.32	1.35	1.38	0.30	0.12	0.28	1.23	−0.06	5.65	2.15	1.17
June	0.92	0.95	0.98	1.01	1.04	1.07	1.10	1.13	1.16	1.19	1.22	1.25	1.28	0.30	0.02	0.28	1.23	−0.16	5.65	2.15	1.07
July	1.00	1.03	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.36	0.30	0.10	0.26	1.16	−0.01	5.65	2.15	1.15
August	1.07	1.10	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.40	1.43	0.30	0.17	0.25½	1.14	0.08	5.65	2.15	1.22
September	1.16	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.40	1.43	1.46	1.49	1.52	0.30	0.26	0.26	1.16	0.15	5.65	2.15	1.31
October	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67	1.70	1.73	0.30	0.47	0.28½	1.24	0.28	5.65	2.15	1.52
November	1.47	1.50	1.53	1.56	1.59	1.62	1.65	1.68	1.71	1.74	1.77	1.80	1.83	0.30	0.57	0.31	1.33	0.29	5.65	2.15	1.62
December	1.47	1.50	1.53	1.56	1.59	1.62	1.65	1.68	1.71	1.74	1.77	1.80	1.83	0.30	0.57	0.34⅜	1.46	0.16	5.90	2.34	1.62
1916																					
January	1.47	1.50	1.53	1.56	1.59	1.62	1.65	1.68	1.71	1.74	1.77	1.80	1.83	0.30	0.57	0.32	1.37	0.25	5.90	1.78	1.62
February	1.47	1.50	1.53	1.56	1.59	1.62	1.65	1.68	1.71	1.74	1.77	1.80	1.83	0.30	0.57	0.32½	1.38	0.24	5.90	1.78	1.62
March	1.44	1.47	1.50	1.53	1.56	1.59	1.62	1.65	1.68	1.71	1.74	1.77	1.80	0.30	0.54	0.36½	1.52	0.07	5.90	1.78	1.59

April	1.36	1.39	1.42	1.45	1.48	1.51	1.54	1.57	1.60	1.63	1.66	1.69	1.72	0.30	0.46	0.35½	1.49	0.02	5.90	1.78	1.51
May	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.42	1.45	1.48	1.51	0.30	0.25	0.30½	1.31	−0.01	6.00	1.86	1.30
June	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.42	0.30	0.16	0.29½	1.28	−0.07	6.00	1.86	1.21
July	1.17	1.20	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	0.30	0.27	0.28½	1.24	0.08	6.00	1.86	1.32
August	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.42	1.45	1.48	1.51	1.54	1.57	0.30	0.31	0.30½	1.31	0.05	6.00	1.86	1.36
September	1.31	1.34	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67	0.30	0.41	0.32½	1.39	0.07	6.00	1.86	1.46
October	1.56	1.59	1.62	1.65	1.68	1.71	1.74	1.77	1.80	1.83	1.86	1.89	1.92	0.30	0.66	0.35½	1.49	0.22	6.25	2.05	1.71
November	1.86	1.89	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.16	2.19	2.22	0.30	0.96	0.39½	1.63	0.38	6.75	2.44	2.01
December	1.86	1.89	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.16	2.19	2.22	0.30	0.96	0.39	1.61	0.40	6.75	2.44	2.01
1917																					
January	1.86	1.89	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.16	2.19	2.22	0.30	0.96	0.39	1.61	0.40	6.75	2.06	2.01
February	2.05	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.38	2.41	0.30	1.15	0.41	1.68	0.52	6.75	2.06	2.20
March	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.16	2.19	2.22	2.25	2.28	0.30	1.02	0.42	1.72	0.35	7.25	2.44	2.07
April	1.85	1.88	1.91	1.94	1.97	2.00	2.03	2.06	2.09	2.12	2.15	2.18	2.21	0.30	0.95	0.46	1.86	0.14	7.25	2.44	2.00
May	1.55	1.58	1.61	1.64	1.67	1.70	1.73	1.76	1.79	1.82	1.85	1.88	1.91	0.30	0.65	0.40	1.65	0.05	8.00	3.04	1.70
June	1.60	1.63	1.66	1.69	1.72	1.75	1.78	1.81	1.84	1.87	1.90	1.93	1.96	0.30	0.70	0.39	1.61	0.14	7.50	2.64	1.75
July	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.16	2.19	2.22	2.25	2.28	2.31	0.30	1.05	0.38½	1.59	0.51	7.50	2.64	2.10
August	2.25	2.28	2.31	2.34	2.37	2.40	2.43	2.46	2.49	2.52	2.55	2.58	2.61	0.30	1.35	0.39½	1.63	0.77	7.50	2.64	2.40
September	2.25	2.28	2.31	2.34	2.37	2.40	2.43	2.46	2.49	2.52	2.55	2.58	2.61	0.30	1.35	0.44	1.79	0.61	7.50	2.64	2.40

manufactures have not been established with such degree of equity.

The claim has frequently been made that the farmer producing milk to be used in the manufacture of condensed milk has not had his fair share of the receipts for the condensed product.

It will be the purpose of this article to inquire into this claim and especially to ascertain if there has customarily been any degree of fixed relationship between the raw milk prices paid to the producer and the selling prices of the finished product.

In taking up these studies it is obvious that one must know the prices which have been paid to producers over a considerable period of time, the kind of goods which have been manufactured, the amount of raw milk necessary for making a unit package of this finished goods, the other costs of manufacture, the costs of advertising and selling, and the jobbing prices at which the goods have been sold.

For the sake of definiteness, the studies reported in this article will be limited to a single brand of sweetened condensed milk.

This brand is a standard brand and for the purposes of this article will be called Brand X. It was manufactured by Condensing Company M in factory K. Further, practically all the milk received at factory K was used in the manufacture of this particular brand. Other factories operated by Company M also made the same grade of product and their output was marketed under the common brand.

On April 1, 1915, Company M began buying milk upon a butter fat or Babcock test basis. Legal milk in their territory was required to show 3 per cent butter fat. For milk showing this minimum test a basic price was paid and for every 0.1 per cent of butter fat above the minimum test 3 cents per hundredweight were added to the price of the milk. No increase in price on account of butter fat content was allowed for milk testing above 4.2 per cent.

The first section of table 1 records the monthly price schedules for a period of thirty consecutive months.

Since the milk price was increased 3 cents for every 0.1 per cent of butter fat one concludes that 30 cents per pound was allowed for the butter fat content of the milk. This assumption is further justified by the fact that an Elgin butter fat price of 30 cents per pound was coincident with the first monthly price schedule quoted.

Column 3 shows the price allowance for the solids not fat content in each hundredweight of milk purchased. In column 4 the proximate average monthly price of butter fat in gathered cream is set down, for reference purposes. This price is the average Elgin price plus 1 cent.

Milk which is accepted for condensing purposes would, if skimmed immediately upon delivery at the factory, produce a cream suitable for city market cream trade or for ice cream making. The ruling price for cream of this grade during the period under consideration was 8 cents net above Elgin. Column 5 shows the possible receipts from the sale of such cream from 100 pounds of 3.5 per cent milk, while column 6 shows the allowance for the skim milk left from the skimming of 100 pounds of 3.5 per cent milk.

When one studies column 4 and notes that during the period of thirty months butter fat increased in price about 40 per cent and then looks at column 2, it is fairly evident that the milk was not bought on a butter fat basis. Further, a glance at column 6 will convince the most casual observer that no attempt was made to assign stable market values to the solids not fat.

Was the price paid for the milk based on the selling price of the finished product?

Before we can answer this question one must prepare cost schedules.

In that most valuable contribution to dairy literature, "Condensed Milk and Milk Powder," second edition by Prof. O. F. Hunziker, Chapter XXII, a discussion of costs of manufacture is given, followed by grouped schedules on page 189. A copy of the cost sheet for a forty-eight can case of Sweetened Condensed Milk, containing 46.4 pounds of condensed milk, net, and prepared for the prices prevailing in 1913 is as follows:

116 pounds milk at $1.50 per 100 pounds	$1.74
18.6 pounds, using 16 pounds per 100 pounds milk, cane sugar at 5 cents	0.93
Tin cans	0.45
Boxes	0.075
Labels	0.04
Solder and gasoline	0.035
Coal	0.045
Labor	0.25
Interest on investment and insurance	0.03
Freight	0.12
Selling expense	0.30
Total cost per case	$4.015

Analyses of samples of Brand X milk taken from random cans of similar size showed that the brand under consideration contained 45.56 pounds of condensed milk, net, that 18.15 pounds of cane sugar had been used per case, and that 113.1 pounds of 3.5 per cent milk were necessary for its manufacture.

Inasmuch as these amounts correspond quite closely with those given by Hunziker and since there must be some allowance for wastage in the processes of manufacture we shall use Professor Hunziker's entire cost schedule and alter the same in those items only which increased in cost during the period from 1913 to September 30, 1917.

After the collection of a large amount of data an analysis of the price increases for the commodities necessary in milk con-

TABLE 2

	APRIL 1, 1915, TO DECEMBER 31, 1915	JANUARY 1, 1916, TO DECEMBER 31, 1916	JANUARY 1, 1917, TO SEPTEMBER 30, 1917
	per cent	*per cent*	*per cent*
Cans	25.0	75.0	100.0
Boxes	8.5	25.0	33.33
Labels	25.0	75.0	100.0
Gasoline and solder	25.0	75.0	100.0
Coal	37.5	112.0	150.0
Labor	25.0	75.0	100.0
Interest on investment and insurance	None	None	None
Freight	None	None	25.0
Selling expense	12.5	37.5	50.0

densing and canning showed that where just ordinary business foresight in buying and contracting was used the percentage increases over the 1913 prices would hold true for the periods of time under which they are placed in table 2.

The above percentage increases have been treated with considerable liberality, and manufacturers buying in considerable quantity and with a view to future needs could have effected substantial savings thereby. The sugar prices to be used are 5.6 cents per pound for the first period, 6.4 cents for the second, and 7¼ cents for the third period. Considerable additional economies were also possible in the sugar purchases.

From April 1, 1915, to November 30, 1915, the jobbing price per case of Brand X milk was $5.65.

The foregoing information enables one to construct the following cost schedule.

Cost schedule: April 1, 1915 to November 30, 1915

	COSTS FOR 1913		COSTS FOR 1915
18.6 pounds sugar at 5 cents	$0.93	(increased 12.0 per cent)	$1.04
Cans	0.45	(increased 25.0 per cent)	0.56
Boxes	0.075	(increased 8.5 per cent)	0.08
Labels	0.04	(increased 25.0 per cent)	0.05
Solder and gasoline	0.035	(increased 25.0 per cent)	0.05
Coal	0.045	(increased 37.5 per cent)	0.06
Labor	0.25	(increased 25.0 per cent)	0.31
Interest on investment and insurance	0.03	(no increase)	0.03
Freight	0.12	(no increase)	0.12
Selling expense	0.30	(increased 12.5 per cent)	0.34
116 pounds milk			2.50
10 per cent profit			0.51
Jobbing price per case			$5.65
Possible price to farmers per 100 pounds of 3.5 per cent milk			$2.15

It is evident that the 10 per cent profit item can be obtained from the jobbing price of the case. These two items being known, together with the first ten items of the schedule, the allowance for 116 pounds of milk can be obtained by difference, and from this the hundredweight price is had.

Since a new cost schedule must be prepared for every change in

TABLE 3

Cost schedules per case of forty-eight cans of Brand X sweetened condensed milk

	COSTS, 1913	INCREASE, APRIL 1, 1915, TO NOVEMBER 30, 1915	COSTS, APRIL 1, 1915, TO NOVEMBER 30, 1915	INCREASE, DECEMBER 1, 1915, TO DECEMBER 31, 1915	COSTS, DECEMBER 1, 1915, TO DECEMBER 31, 1915	INCREASE, JANUARY 1, 1916, TO APRIL 30, 1916	COSTS, JANUARY 1, 1916, TO APRIL 30, 1916	INCREASE, MAY 1, 1916, TO SEPTEMBER 30, 1916,	COSTS, MAY 1, 1916, TO SEPTEMBER 30, 1916	INCREASE, OCTOBER 1, 1916, TO OCTOBER 31, 1916	COSTS, OCTOBER 1, 1916, TO OCTOBER 31, 1916	INCREASE, NOVEMBER 1, 1916, TO DECEMBER 31, 1916	COSTS, NOVEMBER 1, 1916, TO DECEMBER 31, 1916	INCREASE, JANUARY 1, 1917, TO FEBRUARY 28, 1917	COSTS, JANUARY 1, 1917, TO FEBRUARY 28, 1917	INCREASE, MARCH 1, 1917, TO APRIL 30, 1917	COSTS, MARCH 1, 1917, TO APRIL 30, 1917	INCREASE, MAY 1, 1917, TO MAY 31, 1917	COSTS, MAY 1, 1917, TO MAY 31, 1917	INCREASE, JUNE 1, 1917, TO SEPTEMBER 30, 1917	COSTS, JUNE 1, 1917, TO SEPTEMBER 30, 1917
		per cent		*per cent*		*per cent*		*per cent*		*per cent*		*per cent*		*per cent*		*per cent*		*per cent*		*per cent*	
18.6 pounds sugar at 5 cents	$0.93	12.0	$1.04	12.0	$1.04	28.0	1.19	28.0	$1.19	28.0	$1.19	28.0	$1.19	45.0	$1.35	45.0	$1.35	45.0	$1.35	45.0	$1.35
Cans	0.45	25.0	0.56	25.0	0.56	75.0	0.79	75.0	0.79	75.0	0.79	75.0	0.79	100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90
Boxes	0.075	8.5	0.08	8.5	0.08	25.0	0.09	25.0	0.09	25.0	0.09	25.0	0.09	33.33	0.10	33.33	0.10	33.33	0.10	33.33	0.10
Labels	0.04	25.0	0.05	25.0	0.05	75.0	0.07	75.0	0.07	75.0	0.07	75.0	0.07	100.0	0.08	100.0	0.08	100.0	0.08	100.0	0.08
Gasoline and solder	0.035	25.0	0.05	25.0	0.05	75.0	0.06	75.0	0.06	75.0	0.06	75.0	0.06	100.0	0.07	100.0	0.07	100.0	0.07	100.0	0.07
Coal	0.045	37.5	0.06	37.5	0.06	112.0	0.10	112.0	0.10	112.0	0.10	112.0	0.10	150.0	0.12	150.0	0.12	150.0	0.12	150.0	0.12
Labor	0.25	25.0	0.31	25.0	0.31	75.0	0.44	75.0	0.44	75.0	0.44	75.0	0.44	100.0	0.50	100.0	0.50	100.0	0.50	100.0	0.50
Interest on investment and insurance	0.03	none	0.03	none	0.03	none	0.03	none	0.03	none	0.03	none	0.03	none	0.03	none	0.03	none	0.03	none	0.03
Freight	0.12	none	0.12	none	0.12	none	0.12	none	0.12	none	0.12	none	0.12	25.0	0.15	25.0	0.15	25.0	0.15	25.0	0.15
Selling expense	0.30	12.5	0.34	12.5	0.34	37.5	0.41	37.5	0.41	37.5	0.41	37.5	0.41	50.0	0.45	50.0	0.45	50.0	0.45	50.0	0.45
116 pounds milk			2.50		2.72		2.07		2.16		2.38		2.84		2.39		2.84		3.53		3.07
10 per cent profit			0.51		0.54		0.53		0.54		0.57		0.61		0.61		0.66		0.72		0.68
Jobbing price per case			$5.65		$5.90		$5.90		$6.00		$6.25		$6.75		$6.75		$7.25		$8.00		$7.50
Possible price to farmers per hundredweight of 3.5 per cent milk			$2.15		$2.34		$1.78		$1.86		$2.05		$2.44		$2.06		$2.44		$3.04		$2.64

cost of materials and for each jobbing price per case, all the cost schedules necessary for the thirty months are grouped together in Table 3.

A complete list of the monthly jobbing prices for cases of Brand X condensed milk will be found in column 7 of table 1. The monthly prices which could have been paid for 100 pounds of 3.5 per cent milk and still have enabled Company M to have 10 per cent profit will be found in column 8 of the same table. In column 9 there are written down for purposes of comparison the prices which Company M actually paid the producers for 3.5 per cent milk. These last three columns of table 1 are worthy of careful consideration.

On April 1, 1915, the jobbing price of the finished product was $5.65 per case and remained constant for eight consecutive months. According to the cost schedules the company could have paid the farmers $2.15 for 3.5 per cent milk during the entire time. They did, however, pay $1.38 for April milk, $1.17 for May milk, $1.07 for June milk, $1.15 for July milk, and $1.22 for August milk. The average price paid for the four months, May, June, July, and August average $1.00 per hundredweight below the price which could have been paid and still have effected a 10 per cent profit to the manufacturers.

In December, 1915, the case price was raised 25 cents while the whole milk price was unchanged. In May, 1916, the case price was raised 10 cents, during the same month the whole milk price was lowered 21 cents. In March, 1917, the case price was advanced 50 cents, while the whole milk price was lowered 13 cents. In May, 1917, the case price was raised to $8.00, the top point. In the same month the milk price was reduced to $1.70 per hundredweight which was the low point for the entire year, although the cost figures show that the company could have paid $3.04 per hundredweight and still have made the necessary measure of profit which has been called consistent for those carrying out government supply contracts.

In reviewing the facts it is evident that the selling price of the case of manufactured goods was not used as a controlling factor in determining the prices to be paid to producers.

In the anticipated period of civic and industrial reconstruction may we not look forward to the time when the prices paid farmers for milk for condensing purposes shall be governed in a more equitable manner; and bear some fair and direct relationship to the jobbing prices of the finished product?

A STUDY OF THE BIRTH WEIGHT OF CALVES[1]

C. H. ECKLES

Department of Dairy Husbandry, University of Missouri, Agricultural Experiment Station, Columbia, Missouri

The marked variations in the size of calves at birth has attracted the attention of all close observing cattle breeders. Such observations naturally raise questions concerning the extent and cause of such variations, as well as their possible significance from the standpoint of the future welfare of the animal.

A limited amount of data on this subject have been reported by Beach (1), Henry and Morrison (2), and Eckles (3). The new data to be represented were taken under the supervision of the author, and represent those accumulated during a period of twelve years from the dairy herd owned by the University of Missouri.

The animals included were all pure bred and registered. The Holsteins and Ayrshires represented lines of breeding common in prominent herds and are considered to be entirely typical of the breeds. The Jerseys were of the line of breeding generally known as the American type, although, some of the younger animals represent one-fourth or one-half of the blood of those lines of breeding known as the Island Type. The dairy Shorthorns were registered Shorthorns and represent the extreme dairy type of this breed. The lines of breeding represented, however, are among those used in the very best known herds of this breed. Unfortunately, the Guernsey breed is not represented in this herd and consequently no data are available.

For the past twelve years each calf dropped in the University of Missouri herd has been weighed soon after birth, usually within five hours. The dams have been weighed, under conditions as

[1] Published by permission of the Director of the Missouri Agricultural Experiment Station. The same paper will be published as Research Bulletin 35, Missouri Agricultural Experiment Station.

near uniform as practical, for three days in succession following calving and the average used as the weight of dam following calving.

One of the difficulties encountered in compiling data of this kind is to determine where the line shall be drawn between normal and abnormal gestation periods. As a result of accident or contagion the foetus may be expelled at any point during gestation. The question as to what is normal arises especially with gestation periods decidedly shorter than usual but which result in a living calf that may be raised to maturity.

The Earl of Spencer (4), in his well known report concerning the gestation period of cattle, states that the shortest gestation period from which he was able to raise the calf born was 242 days but he also states that any gestation less than 260 days must be considered premature. Wing (5), in his study of 192 gestation periods, reports that the shortest was 264 days. In the compilation of the data here given gestation periods less than 260 days have been omitted. A few calves born following a gestation period shorter than this have been successfully raised but such cases are clearly abnormal and it is considered fair to draw the line at this point.

RELATION OF BREED AND SEX TO BIRTH WEIGHT

The most important factor influencing the weight of the calf at birth is that of breed. Table 1 gives the data on this point. It shows that the Jersey calf, averaging 55 pounds, is the smallest for the breeds represented, and the Holstein with an average of 90 pounds is the largest. The figures expressing the weight of the calf in percentage of the weight of the dam shows that the Jersey not only has the smallest calf in weight but that the calf is the smallest in proportion to the dam. The Holstein calf, in addition to being the largest of all in weight, is also the largest in proportion to the weight of the dam. These data also bear out the common opinion that male calves average larger at birth than do females. The Jerseys and Holsteins show a difference of five pounds between the sexes, the Shorthorns less, but the Ayr-

shires still more. Figure 1 shows the frequency distribution of the weights of the 196 calves of the Jersey breed including both sexes. It will be noted that over 60 per cent of all birth weights fall within 48 to 62 pounds which is within a limit of seven pounds each side of the average.

TABLE 1

Birth weight of calves, University of Missouri herd

BREED	AVERAGE OF BOTH SEXES		MALES		FEMALES		WEIGHT OF CALF IN PROPORTION TO DAM
	Number	Average weight	Number	Average weight	Number	Average weight	
		pounds		*pounds*		*pounds*	*per cent*
Jersey	196	55	102	58	94	53	6.5
Holstein	154	90	69	93	85	88	8.0
Ayrshire	53	69	27	73	26	65	6.9
Dairy Shorthorn	30	73	11	74	19	73	6.0

TABLE 2

Birth weights of calves of the dairy breeds. (All available data)

BREEDS	NUMBER OF CALVES	AVERAGE WEIGHT BOTH SEXES	AVERAGE WEIGHT OF DAMS
		pounds	*pounds*
Jersey	253	55	867
Holstein	229	89	1137
Guernsey	57	71	996
Ayrshire	80	72	983
Brown Swiss	5	100	1123
Dairy Shorthorn	30	73	1216

Table 2 is a combination of all data available for dairy breeds including those presented in this paper and those summarized by Henry and Morrison (6).

RELATION OF AGE OF DAM

Table 3 gives the data for the Jersey and Holstein breeds arranged to show the average weight of calves in relation to the age of the dam. The dams averaged close to twenty-nine months of age at the time of birth of the first calf. The intervals between

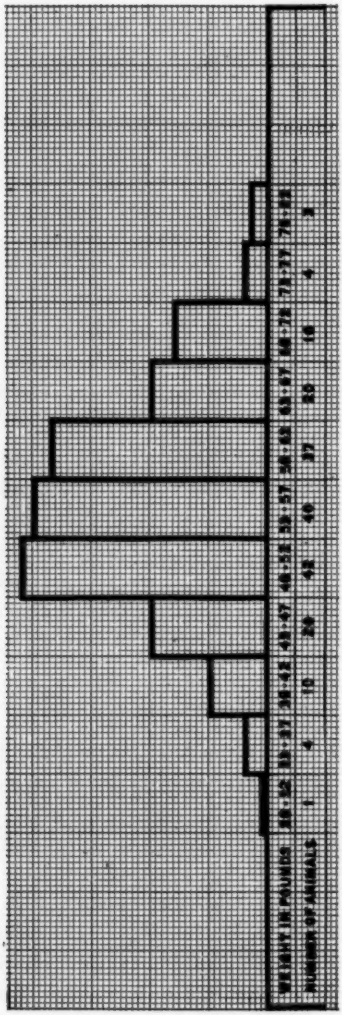

FIG 1. FREQUENCY DISTRIBUTION OF THE WEIGHTS OF JERSEY CALVES AT BIRTH INCLUDING BOTH SEXES. THE AVERAGE WEIGHT WAS 55 POUNDS

the birth of successive calves in the herd from which the data are taken average about thirteen months. For this reason it cannot be assumed, as might be possible in some commercial herds, that the first calf represents an age of two years for the dam, and each successive calf an interval of a year. The data shows that the first calf is noticeably smaller than the second and third, and smaller than the average for the breed. On the average the maximum weight for calves at birth will be found among those representing from the third to the sixth calf of the dam. The

TABLE 3

Influence of age of dam upon weight of calf at birth

NUMBER OF CALF	JERSEYS		HOLSTEINS	
	Number of calves included	Average weight	Number of calves included	Average weight
		pounds		*pounds*
First	44	51	45	85
Second	35	55	31	88
Third	35	58	26	95
Fourth	18	62	19	93
Fifth	13	58	10	101
Sixth	16	52	5	90
Seventh	14	56	7	103
Eighth	8	56	5	98
Ninth	4	53	5	85
Tenth	3	64	2	89
Eleventh	3	51		
Twelfth	2	50		

number of calves from cows of advanced age is too limited for a safe conclusion to be drawn concerning the relation of extreme age to size of the calf. There are, however, indications of a tendency for the calves to be somewhat smaller after the sevens or eight is reached, which represents an age of ten to twelve years for the dams. Between the ages of five and ten years the cow is, ordinarily, at her best for milk and the calves are at the maximum in size. Experience indicates that the same holds true regarding the vigor of the calves from cows between these ages.

LENGTH OF GESTATION PERIOD

Another possible factor influencing the weight of the calf at birth is the length of the gestation period. The expulsion of the foetus before the normal time would be expected to result in an undersized calf. As previously mentioned it is a difficult matter to decide how short the gestation period may be and still be classed as normal. The data given do not include any less than 260 days. Table 4 gives the average length of the gestation period for Jersey calves grouped according to weight at birth. It appears from these data that the length of the gestation period

TABLE 4

Relation of length of gestation period of Jersey cows to weight of calf at birth

NUMBER OF ANIMALS	WEIGHT LIMITS	GESTATION PERIOD
	pounds	*days*
4	33 to 37	274
10	38 to 42	277
20	43 to 47	279
42	48 to 52	281
41	53 to 57	281
34	58 to 62	282
19	63 to 67	284
13	68 to 72	284
3	73 to 77	281
3	78 to 82	285

is correlated to some extent with the size of the calf at birth, since the length of the gestation period is clearly longer for larger calves. This factor, however, is one of limited importance.

RELATION OF THE SIZE OF THE DAM

Table 3 shows that on the average the first calf is lighter in weight than those born from mature animals. It is not clear from these data whether the cause of the lower weight for first calves is the smaller size of the dams or the immaturity in age. This point was studied further by compiling the weights of the dams of the Holstein breed, following the first parturition into

groups based upon their weights. These data are given in table 5. These figures show a consistent relation between the weight of the dam and of the calf and suggest that the smaller weights of the first calves of heifers is probably due to the smaller size of the dam rather than to her immaturity. Data are not available for a sufficient number of undersized mature cows to carry the comparison farther. That the breed factor is also present is shown by the fact that the calves from the young cows are somewhat heavier in proportion to their dams than those from the mature cows.

TABLE 5

Influence of weight of dam upon weight of calf at birth

	AVERAGE WEIGHT OF DAM	AVERAGE WEIGHT OF CALF	WEIGHT IN PROPORTION TO DAM
	pounds	*pounds*	*per cent*
800 to 900 pounds	834	79	9.4
900 to 1000 pounds	948	87	9.4
1000 to 1100 pounds	1090	92	8.4

THE INFLUENCE OF THE SIRE ON WEIGHT OF CALVES

The possible relation of the sire to the size of the offspring is of interest in considering the factors that may influence the size of the calves at birth. Mumford (7), concluded from his observations with sheep that the size of the sire did not exert any influence upon the birth weight of the lambs. The data available concerning the birth weight of calves, although more extensive than yet reported involve the offspring from many sires and a safe basis, is not furnished for generalization on this point. However, a study of the data from this standpoint does not indicate any variation than can safely be attributed to this cause.

The data include a few cases of cross breeding and these show unmistakable evidence that under these conditions the sire does influence the size of the offspring. Calves dropped by three pure bred Jersey cows and sired by a pure bred Holstein bull, averaged 73 pounds in weight while other calves from the same cows sired by a Jersey bull, averaged 56 pounds in weight. Three calves

sired by a Holstein bull from Ayrshire cows averaged 80 pounds compared with an average of 66 pounds for three calves from the same cows by Ayrshire bulls.

NUTRITION OF DAM

It is often assumed that the size of calf at birth is influenced directly by the feeding of the dam during gestation. Such an assumption is not born out by an available data from an investigation by the author. While the data in question were not taken for this special purpose, they have a bearing on the question.

One group of Jersey and Holstein heifers used in an investigation previously reported by the author (8), were fed a liberal ration from birth to first calving for the purpose of obtaining rapid growth and maintaining a state of flesh far above normal. The ration for the first six months was whole milk with as much grain and alfalfa hay as would be consumed. As a result of this manner of feeding, the Holstein group at 19 months averaged 932 pounds in weight compared to the normal of 715 pounds for animals of this breed at this age. The second group represented the same breeds and received skim milk and legume hay up to the age of six months, and from that age on to the time of first calving, only roughage of good quality. As a result the Holsteins of this group at nineteen months averaged 588 pounds in weight, or 127 pounds below the normal weight for the breed and 344 pounds below the group receiving the liberal ration. A portion of each of these groups was bred to calve at what would be considered an early age for the breed—twenty to twenty-two months for the Jersey and twenty-two to twenty-four months for the Holstein. The others were bred to calve at what would be considered a late age, which was thirty-two to thirty-four months for the Jerseys and thirty-four to thirty-six months for the Holsteins. The data in table 6, give the weights of the calves by groups, and the weights of the dams following calving.

These data show that the light fed Jerseys weighing 673 pounds produced calves even a little heavier on the average than those from the heavy fed group which averaged 263 pounds more in

weight. The calves from the light fed Holsteins averaged only 2 pounds less than those from the heavy fed group which weighed 177 pounds more. If the results are expressed in terms of percentage of the weight of the dam, the results are even more striking. The calves from the light fed Jerseys weighed 7.4 per cent of the weight of their dams; the heavy fed Jerseys 4.7 per cent; the light fed Holsteins 9.1 per cent and the heavy fed Holsteins 7.8 per cent. These data show that the breed is a much stronger factor in determining the size of a calf than the condition of the cow during gestation.

It is a common observation by cattlemen that cows poor in flesh to the point of emaciation, may bear calves of normal size for the breed. The data and observations taken by the author

TABLE 6

Influence of nutrition of mother upon weight of calf at birth

	NUMBER OF ANIMALS	AVERAGE WEIGHT COW FOLLOWING CALF'S BIRTH	LENGTH GESTATION PERIOD	AVERAGE WEIGHT OF CALF
		pounds	*days*	*pounds*
Light fed Jerseys	8	673	281	50
Heavy fed Jerseys	7	936	276	44
Light fed Holsteins	8	855	276	79
Heavy fed Holsteins	6	1032	275	81

bear out this statement. On the other hand, cows fattened to excess during gestation, may have calves small for the breed and lacking in vigor as well. Apparently it is only extreme cases of poor nutrition or the lack of some constituent in the ration covering a long period of time that may be expected to exert any marked influences upon the size of the calf.

The relatively small influence of the nutrition of the dam upon the development of the foetus may be explained by the dependence of the foetus for nourishment upon the blood stream of the dam, and therefore, only indirectly upon the food of the dam. It is a well known physiological fact that there is a strong tendency for the composition of the blood to remain almost constant, even under adverse conditions of nutrition. If a temporary def-

icit of any constituent occurs in the blood, the shortage is made up by drawing upon the reserve of that constituent already in the body. For this reason the food supply of the foetus remains practically constant regardless of the food of the dam and in case of a shortage of food during gestation, the mother, and not the foetus, suffers.

CONCLUSIONS

Breed is the most important factor influencing the weight of calves at birth. On the average, calves of the Jersey breed weigh 55 pounds at birth and represent 6.5 per cent of the weight of the dam. Calves of the Holstein breed, at birth, average 90 pounds in weight and represent 8 per cent of the weight of the dams.

Male calves average from 5 to 8 per cent heavier than females.

Calves produced by immature cows, two to four years of age, are smaller than those from mature cows five to ten years of age, There is a tendency for cows of an advanced age to produce calves rather smaller than those from cows in the prime of life.

The length of the gestation period is not correlated with the size of the calf at birth except in cases of extremely large or small calves, when such a relation usually exists.

The sire apparently has but little influence upon the size of the calf at birth, when both sire and dam are of the same breed, but in case of cross breeding the influence of the sire is evident.

The nutrition of the cow during gestation does not influence the size of the calf at birth to any appreciable extent except possibly under most extreme conditions continued for a long interval.

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THE EFFECT OF CORROSIVE SUBLIMATE WHEN USED AS A PRESERVATIVE IN COMPOSITE SAMPLES

H. C. JACKSON

Cornell University, Ithaca, New York

Testing each patron's milk every day involves a large amount of work, so composite tests are used in place of daily tests. Many different methods have been employed to preserve samples of milk. Some work well when the fat test alone is desired but are not satisfactory for a complete analysis.

A great deal of fault has been found with this method of determining the fat content of milk. The most trouble, however, appears to be due to improper sampling.

ABSTRACTS OF WORK DONE BY VARIOUS INVESTIGATORS

Kent (1902) compared the daily and composite tests for a period of thirteen days. There were fifty-two patrons. Three samples were taken as follows from the milk delivered by each patron. A daily test sample, a composite sample obtained by use of a small dipper, and a composite sample for which a Scoville sampling tube was used. The average test was 4.01 per cent, the dipper composite test was 3.95 per cent and the Scoville tube composite was 4.0 per cent.

Potts (1913) carried on the following experiment. He took composite and daily samples in the following manner. Composite A was taken with a little dipper which was attached to a stirring rod, B, was taken with a metal tube which very nearly secured an aliquot portion, and C was taken rather carelessly with a McKay sampler. This milk was delivered by sixty patrons. There were 420 daily tests and 60 composite tests made. This experiment continued seven days with the following results. Daily test, 4.39 per cent; composite A, 4.352 per cent; composite B, 4.363 per cent; composite C, 4.384 per cent.

He ran another set of tests for a period of fourteen days. The samples were all taken in the same manner, giving practically the same results. Daily test, 4.131 per cent; composite A, 4.039 per cent; composite B, 4.00 per cent, and composite C, 4.044 per cent.

While these figures seemed to check very closely, it must be borne in mind that they are the averages of a large number of tests. Errors as large as 0.2 per cent occurred frequently in the individual tests and large errors were not infrequent. There seemed to be a tendency for the errors to be in favor of the manufacturer. The seven day test checked closer than that which extended over fourteen days. Over a long period of time these errors seemed to equalize one another.

The experimental work of these men showed that with ordinary care, good results can be obtained with the composite method. Another cause of error in testing composite samples may be due to the nature of the preservative used. There has been considerable research on the preserving of milk in composite samples. Most of the methods for preventing the growth of microörganisms in milk for future analysis consisted in the addition of metallic salts, or chemicals known to retard bacterial growth.

According to Reichert (1892) metallic salts can be divided into three groups with respect to their effect in retarding fermentation of milk.

(1) Na, K, Li, Mg, Ca, Si, and Ba.
(2) Fe, Mn, Pb, Zn, Ur, and Al.
(3) Cu, Hg, An, Pt, Cd, Co, and Ni.

The latter class is most powerful. In general the rarer metals are more powerful than the more common ones to which the organisms are accustomed.

Patrick (1890) ran tests with various preservatives. Those used were carbolic acid, salicylic acid, salicylate of soda, benzoate of soda, boric acid, mercuric chloride, arsenic acid, arsenious acid and alcohol. He concluded mercuric chloride to be the best. Ten to fifteen grains of mercuric chloride were enough to preserve 200 to 400 cc. of milk in a warm room in winter. A mixture of

fifty parts of weight by powdered borax and ten of mercuric chloride to one of aniline rose pink is very good.

Three years later the same investigator found that 10 to 20 grains of bichromate of potash per 300 cc. of milk was satisfactory for about two weeks, when fermentation set in. The sample gave off odors and decomposition of milk fat took place, reducing the reading 0.3 to 0.4 per cent in a few days. When about one-eighth of mercuric chloride was added with the bichromate it kept milk one month or longer. Forty grains of bichromate alone was not enough to preserve 300 cc. of milk one month. A mixture of bichromate of potash and mercuric chloride in the ratio of 16 to 2 or 4 by weight when 15 to 25 grains were used, would preserve 300 cc. of milk for one month.

Hills (1898) presented the results of investigations made by D. Stewart of the Agricultural Department of the Vermont University on comparative merits of preservatives. He included tests of fifty-seven chemicals, twenty-nine of which had never been used before, and also results obtained by others on the use of ninety-three chemicals of a hundred and twenty-two different chemicals. Mercuric chloride, a mixture of ten parts mercuric chloride and fifty parts borax, bichromate of potash, potassium chromate, sodium sulphite, sodium bisulphite, copper ammonium sulphate, sodium salicylate, and formaldehyde were used. Potassium chromate and bichromate are noted as causing the samples to churn easily and produce tenacious cream, and in warm weather or in steam testers, a black curd. Sodium salicylate has the disadvantage of not dissolving readily and is costly, bulky and inconvenient to handle. Copper ammonium sulphate lessened the miscibility of the sample and gave it an unpleasant odor. Mercuric chloride was criticised as being relatively costly and virulently poisonous. A mixture of mercuric chloride and borax seemed efficient, and was less poisonous than the pure salt. Sodium sulphite and bisulphite had to be used in considerable quantities and did not prevent a putrid smell. Formaldehyde had a single fault, it hardened casein.

Wisconsin Station Bulletin No. 36, July, 1893, page 31. Bichromate of potash was used as a preservative, one hundred and

fourteen samples were tested and all gave as much fat as the original sample. These were kept in a warm room for more than a month. Twenty-five hundredths to five-tenths gram was enough to preserve from a pint to a quart of milk for a week.

According to Newman (1893) once a week is enough to test milk sold at a creamery. Bichromate of potash did not affect the Babcock, Lactocrite, or Gerber's acid butyromety method. The milk remained sweet from one to two months. Chromic acid held milk for about seventeen days. One-half grain of potassium bichromate was enough for 2 pounds of milk and a grain the size of a pin head for 100 cc. The latter is not a good preservative after milk commences to sour. One cubic centimeter of 27 per cent ammonia was added to 350 cc. of milk, and in another test, fifteen drops added to 50 cc. of milk held at a temperature not above 50° F. kept milk sweet for a month. Carbonate and bicarbonate of ammonia were tried but were found to be inferior to ammonia.

Ronnenberg (1893) claimed potassium permanganate would preserve milk even after it had started to sour. When 1 gram to 250 to 500 cc. of milk was added, it kept eight days and showed no sign of curdling.

According to Krueger (1893) when potassium permanganate is added, the milk is colored dark brown at first and gradually becomes lighter colored until it is yellow. If it is allowed to stand without further addition of permanganate it ferments and casein is coagulated. More should be added as soon as milk turns light brown. The use of this preservative did not affect the Babcock test. The sample kept for nineteen days in warm weather when this chemical was employed. It is inferior to bichromate of potash in that it has to be renewed.

Bevan (1895) found that four drops of 40 per cent solution of formaldehyde would keep 4 ounces of milk six weeks or longer.

Thompson (1895) used formalin, boric acid, boric acid and borax, salicylic acid, and benzoic acid, and thought formalin gave the best results.

Lindet (1903) recommended the use of potassium bichromate to 0.5 gram per liter or formalin sixty drops per liter for preserving milk.

McConnell (1904) compared the preserving power of potassium bichromate and formalin for sixteen weeks starting with March. He decided that both were very good but that bichromate was the better because it colored the milk and could be easily and accurately measured.

Gielot (1907) claimed that potassium bichromate even in the proportion of two to one thousand and without the addition of sulphuric acid, produces in milk a substance giving the general reactions of aldehydes which may easily lead to an error as regards the use of formaldehyde as a preservative. The same author found mercuric chloride to give the best results. It is rendered most soluble by adding one quarter of its weight of ammonium chloride. A tablet suitable for preserving a 250 cc. sample of milk would contain 0.05 gram mercuric chloride and 0.000125 of ammonium chloride.

Windisch (1908) ran some tests with potassium bichromate and copper ammonium sulphate. Milk retained its normal characteristics for four weeks with 0.015 to 0.025 per cent solution of copper ammonium. A 2 per cent solution of the latter preserved milk one week longer. It is necessary to use stronger solution in summer than in winter.

Giraid (1909) found that milk preserved with potassium bichromate very often gives erroneous results, the accuracy depending upon the degree of freshness of the milk. It was often found that milk to which potassium bichromate had been added was entirely decomposed within one to two months after taking the sample and that a diminution of fat and casein had taken place. The lactose had been oxidized by the bichromate to the extent of 25 per cent.

Hunziker (1913) found that mercuric chloride did not interfere with the Babcock test and the percentge of fat was the same as that of the fresh sample when held seven, twelve, or fourteen days at 50° and 90° F.

In summing up the results of these investigators, mercuric chloride seems to give the best results. Permanganate of potash, bichromate of potash and formaldehyde, while recommended by some, seemed to have their disadvantages. These

disadvantages may be summed up as follows: The permanganate has to be renewed at the end of a few days, the bichromate is noted as giving a tenacious cream and of charring the fat due to chemical action and the formaldehyde has the bad fault of hardening the casein. Mercuric chloride is criticised because it is very poisonous which seems to be its only fault, as it gave good results in all cases. When using this preservative, it is well to add coloring matter in order to prevent the samples being mixed with other milk. This preservative is handled by dairy supply houses and is put out in tablet form ready for use.

REPORT OF THE AUTHOR'S RESEARCH

A few preliminary trials were made to find out the amount of preservative ($HgCl_2$) necessary to keep the milk for a period of fifteen days. In these tests 300 cc. of milk, the fat test of which was known, was placed in glass bottles having ground glass stoppers and to which varying amounts of the preservative had been added. The amount of mercuric chloride used varied from 0.1 gram to 1 gram. After fifteen days the samples were tested except those in which the milk had coagulated. It was found that in all cases where 0.5 gram and over of preservative was used, the samples did not coagulate and the fat test remained the same.

In composite samples the whole amount of milk at the end of fifteen days is commonly about 150 cc. As this is added in small increments, it would appear that a smaller amount of preservative would keep the milk from souring for fifteen days. To find out if this were true, two sets of milk samples were saved. In the first samples the whole amount of milk (150 cc.) was placed in ground glass stoppered bottles containing 0.1 gram up to 0.8 gram of preservative. At the same time composite samples were prepared containing the same amount of preservative. These were prepared by adding 10 cc. of tested milk each day for fifteen days, so at the end there would be 150 cc. of milk. Both the full amount and the composite samples held for fifteen days without souring except where 0.1 gram of preservative was used.

From these preliminary trials it was assumed that all over 0.5 gram of mercuric chloride would keep 150 cc. to 300 cc. samples for at least fifteen days.

It had been noticed on various occasions when composite samples were being tested for fat that there was a gray feathery mass in the fat column. So far as could be learned this poor appearance of the fat column was not due to improper testing but was thought to be caused by the addition of too much preservative. It was known that the operator of the station from which these samples were obtained, used the mercuric chloride in bulk form. It is the belief in some cases that if a little preservative works satisfactorily a little more will do better. It was assumed then that too much corrosive sublimate was used and that this in some way caused the poor appearance of the fat tests and in some cases made accurate reading difficult.

To find out if relatively large amounts of mercuric chloride interfered with the Babcock milk fat test, ten duplicate composites were run, 0.5 and 1.5 grams of mercuric chloride were employed respectively, 10 cc. of milk was used daily. The acidity and fat content of the milk and the temperature of the room in which they were held was noted. The small amount 0.5 of a gram was used because that seemed to be about the smallest amount that could be employed satisfactorily. The larger amount 1.5 grams was used because it seemed improbable that a dairy plant operator would ever add more than this to a sample. While mercuric chloride is a relatively heavy salt yet 1.5 grams occupies a fairly large volume. The tables show the results obtained.

All the fat tests of the composite samples checked within the limit of error with the computed or average tests of the daily samples.

There was no apparent difference in the appearance of the fat column between the samples having 0.5 gram of preservative or 1.5 grams.

The samples containing 1.5 grams of mercuric chloride gave as accurate a reading as the 0.5 gram samples when compared with the computed tests.

The poor appearance of some fat tests of composite samples does not then appear to be due to excessive amounts of preservative employed.

TABLE 1

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	°*F.*
November 26	3.3–3.3	0.15	
November 27	4.1–4.15	0.14	64
November 28	3.5–3.5	0.14	67
November 29	3.6–3.7	0.15	71
November 30	2.8–2.9	0.13	66
December 1	4.3–4.3	0.15	71
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
Average	3.98	0.149	65.8

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 3.9–3.9 per cent fat;* $HgCl_2$ 1.5 grams, 3.9–3.9 per cent fat.*

* Duplicate tests.

TABLE 2

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	°*F.*
November 27	4.1–4.15	0.14	64
November 28	3.5–3.5	0.14	67
November 29	3.6–3.7	0.15	71
November 30	2.8–2.9	0.13	66
December 1	4.3–4.3	0.15	71
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
Average	4.001	0.149	65.1

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 3.9–3.9 per cent fat;* $HgCl_2$ 1.5 grams, 4.0–4.0 per cent fat.*

* Duplicate tests.

TABLE 3

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	°F.
November 28	3.5–3.5	0.14	67
November 29	3.6–3.7	0.15	71
November 30	2.8–2.9	0.13	66
December 1	4.3–4.3	0.15	71
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
Average	4.005	0.15	64.7

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 3.9–4.0 per cent fat:* $HgCl_2$ 1.5 grams, 3.9–4.0 per cent fat.*

* Duplicate tests.

TABLE 4

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	°F.
November 29	3.6–3.7	0.15	71
November 30	2.8–2.9	0.13	66
December 1	4.3–4.3	0.15	71
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	58
Average	4.185	0.15	64.15

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 4.1–4.1 per cent fat:* $HgCl_2$ 1.5 grams, 4.1–4.1 per cent fat.*

* Duplicate tests.

TABLE 5

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	*°F.*
November 30	2.8–2.9	0.13	66
December 1	4.3–4.3	0.13	71
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	68
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	58
December 14	3.9–3.9	0.15	59
Average	4.201	0.15	63.28

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 4.1–4.2 per cent fat;* $HgCl_2$ 1.5 grams, 4.1–4.1 per cent fat.*

* Duplicate tests.

TABLE 6

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY*	TEMPERATURE
	per cent	*per cent*	*°F.*
December 1	4.3–4.3	0.15	71
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	68
December 14	3.9–3.9	0.15	59
December 16	3.7–3.7	0.165	70
Average	4.262	0.153	63.57

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 4.1–4.15 per cent fat;* $HgCl_2$ 1.5 gram, 4.1–4.1 per cent far.*

* Duplicate tests.

TABLE 7

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	*°F.*
December 2	5.45–5.45	0.155	66
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	58
December 14	3.9–3.9	0.15	59
December 15	3.7–3.7	0.165	70
December 17	4.3–4.2	0.175	55
Average	4.258	0.155	62.42

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, 4.2–4.3 per cent fat;* $HgCl_2$ 1.5 gram, 4.2–4.2 per cent fat.*

* Duplicate tests.

TABLE 8

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	*°F.*
December 3	3.5–3.6	0.15	62
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	58
December 14	3.9–3.9	0.15	59
December 15	3.7–3.7	0.165	70
December 17	4.3–4.2	0.175	55
December 18	4.6–4.6	0.17	63
Average	4.198	0.155	61.5

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram 4.1–4.1 per cent fat;* $HgCl_2$ 1.5 grams 4.1–4.1 per cent fat.*

* Duplicate tests.

TABLE 9

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	*°F.*
December 4	4.1–4.1	0.145	68
December 5	4.1–4.1	0.155	68
December 6	3.4–3.5	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	58
December 14	3.9–3.9	0.15	59
December 15	3.7–3.7	0.165	70
December 17	4.3–4.2	0.175	55
December 18	4.6–3.6	0.17	63
December 19	4.3–4.3	0.175	63
Average	4.251	0.157	62.28

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram 4.2–4.1 per cent fat;* $HgCl_2$ 1.5 gram, 4.2–4.2 per cent fat.*

* Duplicate tests.

TABLE 10

Daily tests of milk forming the composite samples

DATE	FAT*	ACIDITY	TEMPERATURE
	per cent	*per cent*	*°F.*
December 5	4.1–4.1	0.155	68
December 6	3.4–3.4	0.15	69
December 7	3.8–3.9	0.15	66
December 8	4.8–4.8	0.165	60
December 9	4.7–4.7	0.16	58
December 10	3.6–3.6	0.15	56
December 11	4.15–4.2	0.15	59
December 12	6.0–6.0	0.15	58
December 14	3.9–3.9	0.15	59
December 15	3.7–3.7	0.165	70
December 17	4.3–4.2	0.175	55
December 18	4.6–4.6	0.17	63
December 19	4.3–4.3	0.175	63
December 20	4.1–4.1	0.16	63
Average	4.251	0.159	61.9

Tests of the composite samples of the above milk: $HgCl_2$ 0.5 gram, broken; $HgCl_2$ 1.5 grams, 4.2–4.2 per cent fat.*

* Duplicate tests.

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FLY PUPAE IN BOTTLED MILK[1]

WILLIAM A. RILEY

Division of Entomology, University of Minnesota, St. Paul, Minnesota

Late in September last, there was submitted to me for examination a quart bottle of certified milk which bore along the sides some thirty little, tawny gray specks about 2.5 mm. ($\frac{1}{10}$ inch) long and 0.8 mm. ($\frac{1}{30}$ inch) wide. They were immovable and closely attached to the glass and stood out sharply against the white background of the contained milk, as is shown by the photograph reproduced herewith. It is no wonder that they had attracted the attention and the suspicion of the purchaser.

Viewed under the lens, they proved to be the pupae of a minute fly of the genus Drosophila, very closely allied to the common "pomace-fly" which is so abundant around decaying apples and other fermenting substances during the summer and fall of the year.

Desirous of knowing the source of this infestation in the milk and whether so gross a contamination was merely an index of a wholly insanitary condition, I undertook to obtain further details bearing upon the condition. Thanks to the coöperation of Mr. F. K. Linton of the Minneapolis City Health Department, who first brought the subject to my attention, I was enabled to visit five of the large milk distributing centers of the city.

In the interval between the sending of the first specimen and this visit, two additional samples had been sent to Mr. Linton. One of these was a quart bottle of milk, the other a half-pint bottle of cream from one of the best dairies. On the day of our inspection, September 30, I obtained the sample from which my photograph was taken, and at a second station we were told that a good specimen had just been destroyed. The next day two more were submitted. There was a very general agree-

[1] Published with the approval of the Director as Paper No. 146, of the Journal Series of the Minnesota Agricultural Experiment Station.

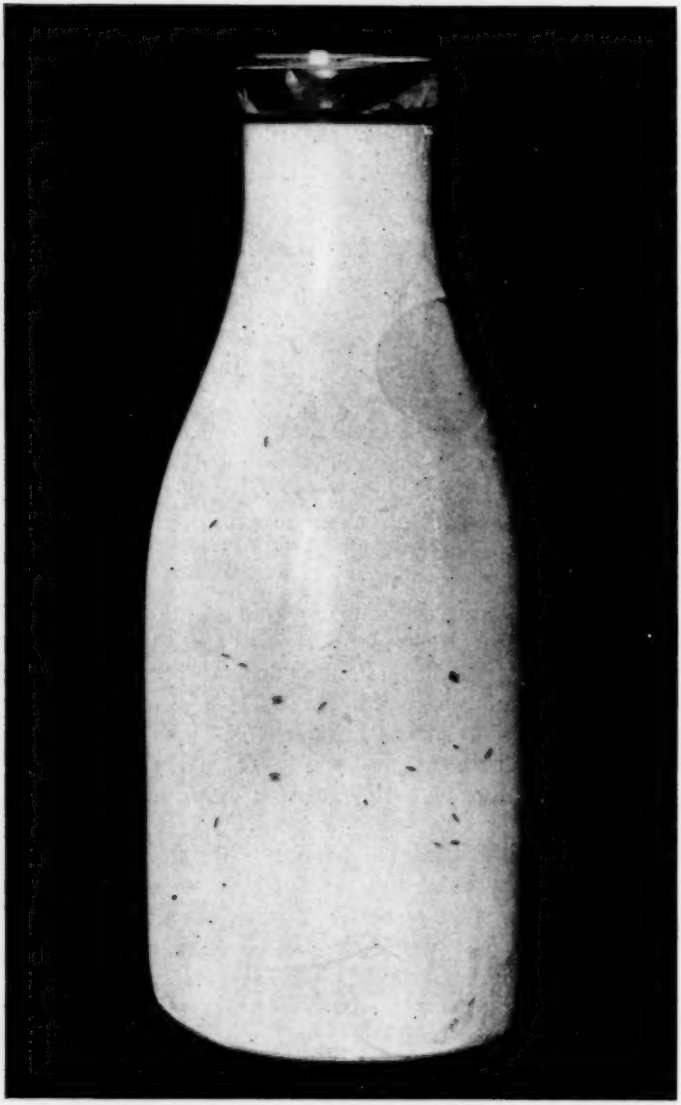

FIG. 1. PHOTOGRAPH OF A BOTTLE OF MILK SHOWING PUPAE OF A POMACE-FLY

ment among the workers in the dairies that instances were much more common a little earlier in the season.

It is evident, then, that the condition is by no means a rare one, though it does not seem to have received any explanation, or even mention, in our literature. At each of the five dairies visited it was well known and the organisms were commonly referred to as "hay-seeds." Some of the employees considered that they originated spontaneously in the milk, two or three of those consulted considered them some form of insect life and believed that they bred in dirty bottles. The latter interpretation is correct.

While I was unable to breed any of the adult flies from the specimens obtained, I obtained from the debris at the bottom of a well infested bottle sufficient remains of eggs and of the several larval stages to exemplify the main features of its life history. Of nearly fifty species of Drosophila which are found in the United States, the life histories of only three or four are known in detail. The best known, thanks to the work of Prof. J. H. Comstock,[2] and to that of numerous workers who have in recent years used it in hereditary studies, is the pomace-fly, *Drosophila ampelophila*. The accompanying figures well illustrate the life history of this species and the résumé of its development is applicable in broad lines to the species here under consideration.

The adult fly (figs. a and b) is about 3 mm. ($\frac{1}{8}$ inch) long and a pale brownish yellow color. It is attracted to decaying fruit or other fermenting substances and there deposits its minute whitish egg about 0.5 mm. ($\frac{1}{50}$ inch) in length. The egg bears a pair of long slender appendages which serve to hold it in place.

In three to five days there hatches from the egg an elongate, whitish maggot which when full grown (fig. e) is 4.5 mm. (nearly $\frac{1}{5}$ inch) in length. About four days after hatching the maggots become restless, migrate to a dry place and there change to pupae within their own dried and somewhat contracted skins (fig. f.). Three to five days later the adult flies emerge.

[2] Rept. of the U. S. Comm. of Agric., 1882, p. 198–201.

In the cases under consideration, the adult flies are attracted to the souring residuum of milk in unwashed bottles about kitchens, restaurants, saloons and other places where they are allowed to stand. Eggs are deposited and within less than a week pupae may have securely attached to the sides of the bottle. In the empty bottle they are inconspicuous, because of their small size and neutral color. When the bottles reach the dairy and

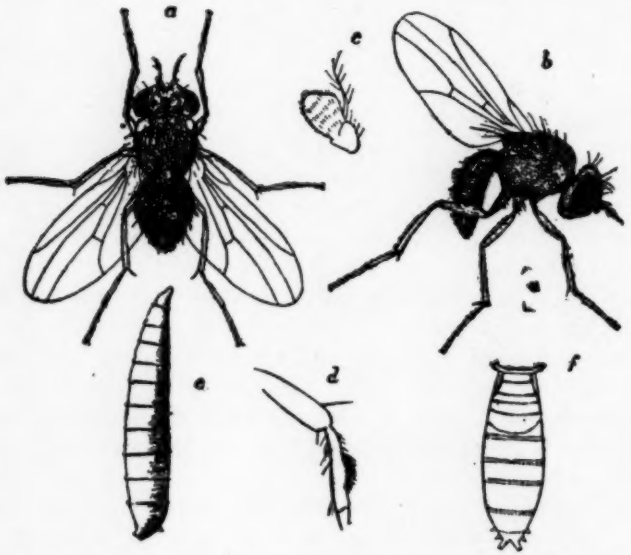

FIG. 2. LIFE HISTORY OF A POMACE-FLY, *Drosophila ampelophila*
a, *b*, adults; *e*, maggot; *f*, pupae.

are put through the washing machine the eggs and larvae are readily washed out, but the pupae, or a portion of them, remain attached. Then, when the bottles are filled, the insects show up conspicuously against the white background. Usually, they are discovered at this point and discarded. Occasionally, an infested one escapes the inspector and reaches the customer.

Flies of the genus Drosophila have been reported as breeding in a wide range of fermenting substances. They are commonly

found in decaying fruit, such as apples, plums, peaches, grapes and the like. They abound about cider mills, vinegar barrels, beer and wine casks. Lintner has reported them as breeding in flour paste, and most significant from the viewpoint of public health, Howard has bred them from human excrement. One untraced reference records them as breeding in rancid butter, but with one exception I have failed to find any reference to their occurring in milk.

The exception is a brief note by Dr. Otto Fettick, in the Zeitschrift für Fleisch und Milchhygiene, 1913, vol. xxiii, p. 252-253. In a bottle of milk from a large central depot in Budapest, he found that "on the inner wall of the bottle there were singly and in groups, forty-two little, spindle-shaped grayish-yellow bodies 1.5 to 2 mm. in length" which he interpreted as larvae of Drosophila or a related genus. From his descriptions it is clear that he mistook the pupae for larvae, which they naturally resemble since they transform within the old larval skin. His specimens were immovable and he also failed to rear any adults.

Fettick inclines to the belief that the larvae gained access to the milk at the producing station, through the use of foul water in washing milk cans or other utensils and that, therefore, such milk was insanitary. He also points out that they might have come from imperfectly washed bottles and that in this case, likewise, the milk would be suspicious.

My study has shown that the latter explanation is the correct one. Fortunately the implication that not only the infested milk but that the milk bottles under similar conditions are insanitary does not necessarily follow. In Fettick's case, as in mine, the failure of the pupae to develop was apparently due to the fact that they had been killed in the course of washing the bottles.

In the better dairies the returned bottles are subjected to a hot, almost boiling, solution of caustic, and are then thoroughly washed in hot water. As they emerge from the machine, they are too hot to be comfortably handled by one unaccustomed to them. In this condition and in the subsequent process of filling and capping, there is no opportunity for the mature flies to gain

access to them and to deposit their eggs. Even if they should do so the milk would be consumed before the eggs had hatched.

Of course, if the sterilization of the bottles is not thorough there is no question but that the contained milk would be a menace to health. The danger is in nowise any greater than that from using improperly sterilized bottles which do not have the insects in them but which have been exposed to house-flies and other insects as well as to air contamination. The whole case affords a striking illustration of the gross contamination to which milk bottles may be subjected, not only in places of business but in homes. If consumers cannot be otherwise induced to wash bottles when they are emptied, common decency demands that ordinances requiring this be enforced.

THE CELLULAR TEST FOR PASTEURIZED MILK UNDER PRACTICAL CONDITIONS[1]

WILLIAM DODGE FROST AND GENEVIEVE D. MOORE

University of Wisconsin, Madison, Wisconsin

This test has been described by one of us (W. D. Frost) under the title of "A Microscopic Test for Pasteurized Milk" in two brief (preliminary) papers.[2]

METHOD

The method briefly stated, consists of mixing with the milk to be tested an equal quantity of a special methylene blue stain. The stain is a 0.015 per cent aqueous solution of methylene blue. A glass tube about 4 inches long and ⅝ inch in diameter, open at both ends, has one end plugged with a rubber stopper (no. 00). Two equal spaces above the cork are then marked off, each about 1½ inches long, with a wax pencil. The milk is poured in until it reaches the first mark and then the methylene blue is slowly added up to the second mark. The stain and milk are thoroughly mixed and allowed to stand for at least ten minutes, although it may stand several hours without interfering with the test. The sediment is then thrown onto the cork by whirling the tubes in an ordinary electrical centrifuge. The fat layer at

[1] The work was done at the Laboratories of the Chicago Health Department through the courtesy of Dr. John Dill Robertson, Commissioner of Health, and Dr. F. O. Tonney, Director of the Laboratories, and made possible by the generosity of the Bowman Dairy Company of Chicago, which furnished a fellowship in bacteriology at the University of Wisconsin for the year 1917–18.

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[2] A Microscopic Test for Pasteurized Milk. Jour. Am. Med. Assoc. 1915, vol. lxiv, p. 821–2.

Microscopic Test for Pasteurized Milk. Report of the 9th Annual Convention of the International Milk Dealers' Association, p. 78, 1916, and Milk Dealer, December, 1916, p. 34.

The complete paper is to appear in the Russell Quarter Century Book now being published.

the top of the tube is then loosened, the milk and stain mixture poured out, the cork removed and the sediment on it carefully spread on a microscopical glass slide, as one would make a blood smear. This smear is allowed to air dry *without coming in contact with water at any time.* When dry it is examined under the microscope with the low power and under the oil immersion objective.

OBSERVATIONS MADE

In this work at least six points in regard to each preparation have been noted:

1. Background. The body of the smear, probably the casein or milk serum, takes the stain in a varying degree. In raw milk the background is usually found to be dark and continuous (d and c in the tables). By this is meant that the entire smear is stained deeper than the nuclei of the leucocytes which are imbedded in it. Usually these are not stained at all. Whether it is actually dark or light depends very evidently upon the thickness of the film and this unfortunately cannot be controlled. In well pasteurized samples the stain of the background is found to be light and variable (l and v in the tables). By this is meant that the stain in the background is lighter than the nuclei of the contained leucocytes. It is variable in that it is usually darker about the leucocytes, forming a more or less distinct "dark halo" about then. Occasionally neither description applies and these are designated in the tables as non-characteristic (n.c.).

2. Stain of the leucocytes. We have examined at least 25 leucocytes in each preparation. In raw milk the leucocytes are unstained and in the typical preparation appear as clear areas in a dark blue field. They are easily differentiated from the fat globules by their larger size and more or less irregular outline. Frequently there is a tinge of blue to them so that there is just a suggestion of the nuclear structure of the cell visible. A few cells even in perfectly fresh milk may have their nuclei stained but less densely and compactly than in pasteurized milk. In the

pasteurized milk, on the other hand, the nuclei are definitely stained, usually dark blue, while the background is lighter. The difference is striking and perfectly characteristic.

3. Size of the leucocytes. The heat of pasteurization not only affects the staining reaction of the leucocytes but it produces a profound change in their size. In raw milk these cells are frequently 10 or 12 microns in diameter and nearly always above 7.5 microns. In properly pasteurized milks they are very much smaller, usually less than 7.5 microns. In the tables and discussions which follow, the size is referred to as large or small by which is meant that they are either more than 7.5 microns or less than that in diameter.

4. Outline of leucocytes. It would seem reasonable to suppose that with the shrinking of the leucocytes there might be a change in form or outline. This has been noted and recorded as regular, irregular or varied (i.e., both).

5. Nuclear fragments. Only the poly-morpho-nucleated cells are of value in this test. In a raw cell it is usual for the nucleus to be single but variously shaped (or poly-morpho-), while in the heated milks there is a pronounced tendency for the nuclei to become separated and thus the cells become polynucleated. The nucleus or its fragments are much more compact and demarkated in the heated than in the raw samples. We have counted the number of nuclei in all of the leucocytes recorded and averaged the nuclear fragments for a single cell and expressed it as an integer, indicating variations from this with the + and − signs.

6. Bacteria. The number of bacteria will depend a good deal, of course, on the speed of the centrifuge, time whirled, the area of the smear, etc. No particular correspondence could be expected with the plate count, especially with pasteurized milks, because of the uncertain reaction of the bacteria to this form of staining (wet). The heat which fixes the nuclei of the leucocytes for staining curiously renders the bacteria less likely to take the stain. It is only in raw milks then that the bacteria stain well. In well pasteurized milks they stain poorly. Frequently the

bacteria take the stain with a varying degree of intensity, but whether this is due to inherent differences in the bacteria or to the effect of the heat on the sample is undetermined. The reaction of the bacteria to the stain is no indication of the amount of heat applied to the sample.

DATA

Complete data have been obtained on 260 samples examined over a period of one month (July, 1918).

It seems unnecessary to tabulate all of the data. In table 1, 15 samples only are presented as representative of the whole number. They were selected mechanically and include 10 pasteurized milks and 5 raw milks.

Forty-seven of the 260 samples examined were reported by the inspectors to be raw. Of these 36 were unhesitatingly recognized as raw milks by the microscopic test. The remaining 9 samples are shown in table 2. A study of this table shows that none of the samples could be regarded as properly pasteurized milks although there is evidence that some of the samples contained milk that had been heated. This is not unlikely since we were told that the producer sometimes heated his milk before it was sent to the city plant, that milk brought back from the route was sometimes thrown in with raw milk and repasteurized, and the samples collected were sometimes taken by the inspector from the pasteurizer.

Of the 213 milks turned in by the inspectors as pasteurized, 26 seem not to have been properly heated when examined by the microscopic test. These milks are shown in table 3. It will be noticed, however, that the first 14 samples in the table (including no. 307) have a high bacterial content, in most cases above 500,000 per cubic centimeter. These very evidently could not be considered as satisfactory pasteurized milks. The remaining 12 samples, however, have a low bacterial content and yet our test would suspicion or condemn them.

TABLE 1

Shows typical data from fifteen milks. Samples chosen at random from the 223 examined and may be taken as representative of the whole number

LABORATORY NUMBER	MICROSCOPICAL EXAMINATION						BACTERIA		KIND, INSPECTOR'S CLASSIFICATION
	Background	Leucocytes							
		Number	Stain	Size	Outline	Nuclear fragments	Stain	Plate count	
1–2894	d and c	–	0 >p	Large	Regular	1–	Well	4,000,000	Raw
10–2902	d and c	–		Large	Regular	0	Well	29,000,000	Raw
20–2909	l and v	–	+	Small	Regular	2	p	20,000	Pasteurized
40–2946	l and v	–	+	Small	Various	2+		530,000	Pasteurized
60–2953	l and v	Many	+	Small	Irregular	2+	p	40,000	Pasteurized
81–2981	l and v	Many	+	Small	Various	2+	p	400,000	Pasteurized
100–3024	l and v	–	+	Small	Various	2+		6,000	Pasteurized
120–3139	l and v	–	+	Small	Irregular	2+	w		Pasteurized
130–3069	d and c	–	0–+	l >s	Various	1+	p	3,700,000	Raw
140–3055	n.c.	–	0–p	Large	Irregular	1	Well	5,000,000	Raw
160–3081	d and c	–	0	Large	Various	0	Well	500,000	Raw
180–3225	l and v	–	+	Small	Various	2+	Well	5,000,000	Pasteurized
200–3221	l and v	Few	+	Small	Various	2+	p	5,000	Pasteurized
250–3415	l and v	Few	+	Small	Regular	2–	p	300,000	Pasteurized
300–3491	l and v	–	+	Small	Various	2+	p	600,000	Pasteurized

TABLE 2

Shows 11 milks reported as raw which the microscopic test indicates have not been properly pasteurized

LABORATORY NUMBER	MICROSCOPICAL EXAMINATION						BACTERIA		KIND, INSPECTOR'S CLASSIFICATION
	Background	Leucocytes							
		Number	Stain	Size	Outline	Nuclear fragments	Stain	Plate count	
35–2914	d and c	–	0–+	l–s	Various	1+	Well	1,300,000	Raw
44–2939	d and c	–	o.p–+	l–s	Various	2	p	1,500,000	Raw
54–2966	d and c	–	+–o.p	Small	Various	2+	p	3,500,000	Raw
101–3015	n.c.	–	+ >0	l–s	Irregular	2–	Well	36,000,000	Raw
102–3031	n.c.	–	+ >0	l–s	Irregular	2–	Various	250,000	Raw
125–3089	d and c	Few	+–0	l >s	Various	2+	Various		Raw
126–3036	d and c	–	+–0	l–s	Irregular	1+	Various	3,200,000	Raw
145–3099	n.c.	Few	+–0	s >l	Various	2–	Various	200,000	Raw
188–3180	n.c.	–	+	Small	Regular	2	p	13,000,000	Raw
280–3469	n.c.	–	0> +	l >s	Various	1	Well	6,000,000	Raw
285–3493	d and c	Many	o.p >+	s >l	Irregular	2+	p	1,000,000	Raw

TABLE 3

Shows 26 samples of milk reported to be pasteurized which would not pass the microscopic test

LABORATORY NUMBER	MICROSCOPICAL EXAMINATION						BACTERIA		KIND. INSPECTOR'S CLASSIFICATION
	Background	Leucocytes							
		Number	Stain	Size	Outline	Nuclear fragments	Stain	Plate count	
21	l and v		o.p+	l s	Various	1	Well	920,000	Pasteurized
41	d and c	Few	o−+	l−s	Various	1+	Well	350,000	Pasteurized
80	l and v	−	o−p	l−s	Various	1	Various	450,000	Pasteurized
84	d and c	−	+−o	s l	Various	2	p	1,000,000	Pasteurized
96	l and v	−	+o	s l	Various	1	Various	4,000,000	Pasteurized
129	l and v	−	p.o	s l	Various	1+	Various	700,000	Pasteurized
142	n.c.	−	p	s	Irregular	2	p	1,500,000	Pasteurized
166	d and c	−	o	l	Irregular	0	Various	900,000	Pasteurized
179	l and v	−	o	l	Various	½−	Well	5,000,000	Pasteurized
183	l and v	−	o	l	Various	0	Well	500,000	Pasteurized
282	d and c	−	+p.o	s l	Various	1+	p	1,200,000	Pasteurized
305	l and v	−	o+	l	Irregular	1−	Well	800,000	Pasteurized
306	n.c.	−	+o	l s	Irregular	1+	Various	500,000	Pasteurized
307	l and v	−	+o	l−s	Irregular	1+	Various	1,500,000	Pasteurized
78	l and v	−	+o	s l	Various	2−	p	3,000	Pasteurized
91	l and v	−	+o	l−s	Irregular	1+	p	45,000	Pasteurized
109	l and v	−	+o	s−l	Irregular	1+	p	24,000	Pasteurized
152	n.c.	Few	+o	l−s	Various	1+	Various	500	Pasteurized
153	l and v	Few	o−p	l−s	Various	1−	Various	2,000	Pasteurized
154	n.c.	Few	o p	l−s	Various	1−	Well	40,000	Pasteurized
155	n.c.	−	o	l and s	Various	1−	Well	40,000	Pasteurized
167	n.c.	−	p o	l	Regular	1−	Well	50,000	Pasteurized
170	n.c.	−	o p	l and s	Various	1	Well	50,000	Pasteurized
171	l and v	−	+p o	l−s	Regular	1+	Well	100,000	Pasteurized
172	l and v	−	+o	s l	Various	2−	Well	19,000	Pasteurized
177	l and v	−	o+	l s	Irregular	1	Well	15,000	Pasteurized

PERCENTAGE OF ERROR

Whether or not it would have been possible, if time and facilities had been available, to have determined the reason for these discrepancies, is problematical. If we give all of the benefit of the doubt to the word of the milk dealer, the inspector, and the bacterial analyst, none of whom, however, are by any means in-

fallible, we have an error of approximately 4 per cent, or, in other words, this method in our investigation proved to be 96 per cent accurate.

SIMPLICITY OF METHOD

Lest the tables and various details indicated in this paper lead the reader to the conclusion that the method is complicated and unreasonably time-consuming, it should be said that the junior author of the paper, who has worked quite independently on the analyses, knew nothing whatever of the technic of this method two weeks before she began this investigation. She had had good laboratory training but acquired her knowledge and experience with this method by working largely by herself in the Wisconsin laboratories for about two weeks. The work in the Chicago Health Department Laboratories has been done by taking a moderate number of samples at random from those coming into the laboratory each day, making the stains and arriving at the diagnoses quite independently of the inspector's report or the findings of the department's bacteriologists, to whom we are in debt for the plate counts. This clearly indicates that no extensive training is necessary or unusual skill needed. Like all similar work, good judgment is essential and this is best acquired by practice.

The time required to make the tests is quite comparable to that consumed in making the Babcock fat test. It is also quite apparent that the mechanical part of the test, at least, can be done by help not highly trained.

In making the diagnoses it is not necessary to fill out tables such as those given above. Ordinarily the slide is first examined under the low power and the light, uneven distribution of the background and the deeper stained leucocytes are noted if the milk has been pasteurized. In a raw milk the background is quite blue in the thicker places in which the unstained leucocytes appear as clear areas, and these can usually be differentiated from the fat globules by their larger size and more irregular outlines.

Each slide would ordinarily next be examined under an oil immersion objective. A few leucocytes are thus studied to determine their staining reaction and the condition of the nuclear fragments. The eyepiece should be provided with a micrometer scale and some of the leucocytes measured. The bacteria will be studied without effort at the same time.

POSITIVE TEST

A properly pasteurized milk should show the nuclei of practically all of the leucocytes in compact masses and well stained and the background lighter than the nuclei, except in the very thickest places. The leucocytes should be small and if the milk has been kept under proper conditions to prevent growth, the bacteria should not be stained at all or at least variably or indistinctly.

SUMMARY AND CONCLUSIONS

The "microscopic test for pasteurized milk" (Frost) has been applied to 260 of the routine milk samples analyzed by the laboratories of the Chicago Health Department during July, 1918. All of the 47 raw samples were correctly placed, although 11 showed indications of having been partly or partially heated. Twenty-six of the 213 pasteurized samples seemed to have been insufficiently pasteurized. Fourteen of these should be condemned by the high bacterial count. This leaves 12 out of the total (260), or about 4 per cent of the samples as being unsatisfactory in spite of the fact that they are supposed to have been pasteurized and have a low bacterial count. This investigation gives strong evidence that the method may be used to control pasteurized milk supplies with a high degree of accuracy and that the method requires neither expensive equipment nor unusual skill and is not excessively time-consuming.

DAIRY STATISTICAL REFERENCES

T. R. PIRTLE

Dairy Division, Bureau of Animal Industry, United States Department of Agriculture

"Next to knowing a thing is knowing where to find it," is an old saying that is very applicable to dairy statistics. A question often asked by persons interested in dairying is, "Where can I find statistics on milk products?" This query is not confined to the student body but comes from all classes. Even those well versed in the details of the industry are apt to be anxious lest they have failed to obtain all the information available, or lest the data at hand are not the latest.

At this time of abnormal markets, prices, and demands, it is well to secure all the data possible relating to the industry in other countries as well as in the United States. Leaders in the dairy industry should familiarize themselves with the true conditions, both present and past, in other countries, and so get a line on their possible future requirements. Thus, when the great readjustment takes place they will be able to more correctly judge the economic conditions, both domestic and foreign.

UNSATISFACTORY CONDITION OF DAIRY STATISTICS

It is not possible to secure complete statistics of dairying, even in several volumes, as no compilation of the official figures has been made and published. In fact, the dairy industry has suffered for a long time in this country because its statistical history has been scattered throughout the reports, bulletins, and circulars of the federal government and the various states, including also the experiment stations and the dairy press. This condition still prevails.

If all the publications of the United States containing dairy statistics were placed on a table with a request that certain data be compiled, one would wonder where to begin and it would

probably require considerable time to look the mass over. The situation is even worse when one goes into a large library to get dairy statistics. The index of the library will give some help, but as it contains so many references which do not pertain to the inquirer's needs, it is of but little help after all, especially if his time is limited. For example, the reports of many countries give the aggregate number of cows, cattle and other stock in one volume, the production of dairy products in another, imports and exports in still another, and so on for the various items relating to the industry. Very few of these items have been tabulated for the different years.

A dairy statistical index would be of great service in saving time in the compilation of data, and also by giving the sources of practically the complete official figures available, it would make further search unnecessary. Such an index should contain several items of information to aid in locating the desired reference, especially: The exact title of the publication, the name of the author (if an individual publication), the date and place of publication, and whether or not the volume is the original source of the figures given.

The utility of such an index can readily be seen. (1) It would be a great time saver; (2) statistics which are published without the authority being given could be verified quickly and thereby become available for use with their proper value; (3) round numbers could be changed speedily to the exact figures, and (4) erroneous figures could be checked and their wrongful effect stopped. In short, it would aid in replacing general impressions with exact figures, destroy prejudices, avoid the repetition of doubtful data, and increase the interest in dairy statistics.

SOME QUESTIONS FOR THE FUTURE

The time has come when dairying in the United States is of very great importance to all other countries and especially to those which have been so grieviously affected by the shortage of food due to the war. The position of the United States in the dairy markets of the world merits careful study. Is it possible for this country to become an export nation? If so, where could

a market be found sufficiently substantial and lasting to warrant the necessary effort and investment? What other nations are forging ahead in dairying and what are their economic limits in the industry? If the people of the United States should consume a normal amount of dairy products, what increase in the industry would be necessary? How could we possibly reach and maintain such an aggregate?

These are some of the questions before the dairy industry for settlement. With the view of assisting in securing information upon which to plan for the future of dairying in the United States, the following list of publications containing statistics relating to the industry is submitted:

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In general, the source of original production figures on dairying is the "Census" reports.

The source of original statistics of imports and exports is the "Commerce and Navigation" reports.

The "Yearbooks" are compiled almost entirely from original sources, but, while very reliable, contain few if any original statistics.

The dates shown following each reference have the following meaning: (1) For the dairy press and periodicals, they relate to date established. (2) For bulletins and circulars, they relate to date of publication. (3) For yearbooks and other regular reports, they relate to the earliest date that should be found in the best statistical libraries and continuing from that date to the present time.

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State Bulletins on Dairy Development.

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Foreign Commerce and Navigation of the United States, annual, U. S. Dept. of Commerce.
Statistical Abstract of the United States, annual, U. S. Dept. of Commerce.
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SOME CORRELATIONS IN THE COST OF MILK PRODUCTION[1]

[*Concluded*]

JOHN A. HOPKINS, JR.
Newark, Delaware

Section IV. Correlation of Amount of Forage Fed to Other Factors in Milk Production

1. Adaption of Data

In this phase of the study, the same principles are followed as in sections II and III. The three groups as to size were each subdivided into three classes, the first of which contained dairies using less than 1.5 tons of forage per cow per year, the second using from 1.5 to 1.9, and the third 2 tons or more. This is illustrated by the following table:

Division of dairies in classes in section IV

CLASS NUMBER	NUMBER HERDS IN CLASS	SIZE OF HERDS	TONS OF FORAGE FED PER COW
44	3	Fewer than 20 cows	Less than 1.5 tons
45	15	20 to 39 cows	
46	15	40 or more cows	
47	6	Fewer than 20 cows	1.5 to 1.9 tons
48	8	20 to 39 cows	
49	8	40 or more cows	
50	22	Fewer than 20 cows	2.0 or more tons
51	7	20 to 30 cows	
52	2	40 or more cows	

This study is complicated by the circumstance noted in section II. That is, a large number of the smaller dairies use large quantities of forage of a cheap nature such as corn stover. This is shown in classes 50 and 51, the first of which uses an average of

[1] Continued from volume 2, no. 2.

3.4 tons and the latter of 3.9 tons per cow. This would give one to think that a large part of this forage is being wasted and that this will be reflected by an unnecessarily large item in expense. As to the first, it is not possible to tell at this time just what portion of the forage is wasted by trampling, etc., and what part is productively used. As to the expense, it may be observed from the tables that the cost of forage in classes 50 and 51 is not so great as in class 52 which uses only about half as much. In other words, the forage so liberally used is of a poor quality and cheap, and more of it is required to obtain a given amount of nutriment. At the same time considerably more may be used without materially increasing expense. The forage used in class 52 is of good quality, composed of alfalfa or clover hay. It is possible that the value of the forage would have provided a more satisfactory basis of comparison than the amount.

2. CORRELATIONS OF THE AMOUNT OF FORAGE FED TO OTHER FACTORS IN MILK PRODUCTION

Size of dairies

It may be seen from the tables that there is a marked tendency for the small dairies to be grouped in the class using the most forage. There are 22 dairies of fewer than 20 cows in class 50, using 2 or more tons of forage per cow, 6 in class 47 use 1.5 to 1.9 tons per cow, and only 3 in class 44 which use less than 1.5 tons per cow. Of the dairies of 20 to 39 cows, 15 use less than 1.58 tons, 8 use 1.5 to 1.9 tons and 7 use 2 tons or more, and of the dairies of 40 or more cows, 15 use less than 1.5 tons per cow, 8 use 1.5 to 1.9 tons and only 2 use as much as 2 tons.

The explanation for this is to be found in the different purposes for which the dairies of different sizes are operated. The small dairies are usually, but not always, intended to consume waste or unmarketable products on farms of varying size, and as was mentioned above, may be considered as side industries, and their products more or less as by-products of grain,—or general farming. The large dairies, on the other hand, are operated as the main industries on the farms where they are found, hence, large

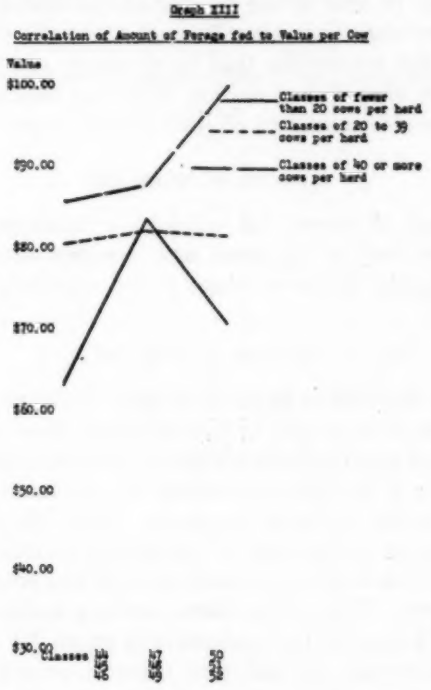
TABLE 4

Section IV. Correlations of the amount of forage fed to other factors in milk production. Averages of classes 44 to 52

CLASS NUMBER	NUMBER OF HERDS	NUMBER OF TENANTS	NUMBER OF OWNERS	AVERAGE NUMBER OF COWS IN HERD	VALUE PER COW	TONS SILAGE FED	TONS FORAGE FED	COST OF FORAGE	POUNDS GRAIN FED	HOURS OF LABOR	QUARTS MILK PER YEAR	TOTAL EXPENSE	TOTAL INCOME	COST PER QUART	PRICE PER QUART	PROFIT OR LOSS PER QUART	RATIO OF FORAGE TO GRAIN*
44	3	1	2	14.0	$63.33	3.7	1.1	$10.43	1,935	135	1,465	$138.99	$78.05	$0.106	$0.047	$−0.059	1:1.1
45	15	3	12	29.2	81.33	3.9	1.1	16.03	2,491	158	2,629	154.47	144.78	0.054	0.049	−0.005	1:0.9
46	15	0	15	60.0	86.00	5.5	1.3	19.70	2,386	184	2,916	169.41	176.42	0.054	0.055	+0.001	1:1.1
47	6	1	5	12.7	84.17	3.0	1.6	23.41	2,859	175	2,384	179.27	141.98	0.076	0.048	−0.028	1:1.1
48	8	2	6	24.0	82.50	3.6	1.7	19.66	2,346	144	2,416	154.67	160.77	0.062	0.061	−0.001	1:1.4
49	8	0	8	67.4	88.75	5.9	1.6	23.01	2,474	199	3,557	189.52	219.98	0.050	0.059	+0.009	1:1.3
50	22	6	16	11.2	71.14	2.3	3.4	25.81	2,435	174	2,073	154.83	109.46	0.071	0.047	−0.024	1:2.8
51	7	1	6	24.9	82.14	2.5	3.9	25.72	2,945	175	2,595	181.16	145.33	0.060	0.053	−0.007	1:2.6
52	2	0	2	70.0	100.00	7.9	2.0	26.65	3,672	231	3,216	215.21	223.59	0.061	0.064	+0.003	1:1.1

* The total amount of grain fed being taken as 1.

amounts of cheap bulky forage are not so likely to be found for them to consume, and they use roughages of better quality and less bulk. The amount of forage which a dairy is likely to be fed is, therefore, largely dependent on the type of the farm on which the dairy is found and on the purpose of the dairy.



Value per cow

It will be observed from graph XIII that there is a tendency for the value per cow to rise as more forage is fed, at least between the group feeding less than 1.5 tons per cow and that feeding 1.5 to 1.9 tons. Above this point two opposing tendencies become evident. In the case of the larger dairies where good qualities of forage are generally used, the value per cow continues to rise

as more forage is fed. Two tons per cow is, however, the largest amount used in dairies of 40 or more cows and only two dairies use this amount. In these cases large amounts of forage are fed because the cows are of great capacity, and are able to make good use of more than the cows in most other dairies. The opposing tendency may be seen in the smaller dairies where the value per cow falls very slightly in class 51 and sharply in class 50. This strengthens the contention that these classes are composed, for the most part, of inefficient dairies, which not only use feed wastefully, but are also composed of cows of poor types.

Amount of silage fed

The amount of forage fed exhibits a tendency to rise as more silage is used in the small and medium sized herds, but decreases slightly as more silage is fed in the group of large dairies.

Amount of grain fed

It may be observed in graph XIV that, in the group of dairies of fewer than 20 cows and in that of 40 or more, the curves for the amounts of grain fed run parallel to those for value, indicating in these cases a tendency, conscious or unconscious, to feed in accordance to the value of the cows. Now, the value per cow may be taken as a composite of productive capacity and market price, so that this is also in accordance with the productive capacity of the cows. This will be borne out by a comparison of these curves with the curves for production in graph XV.

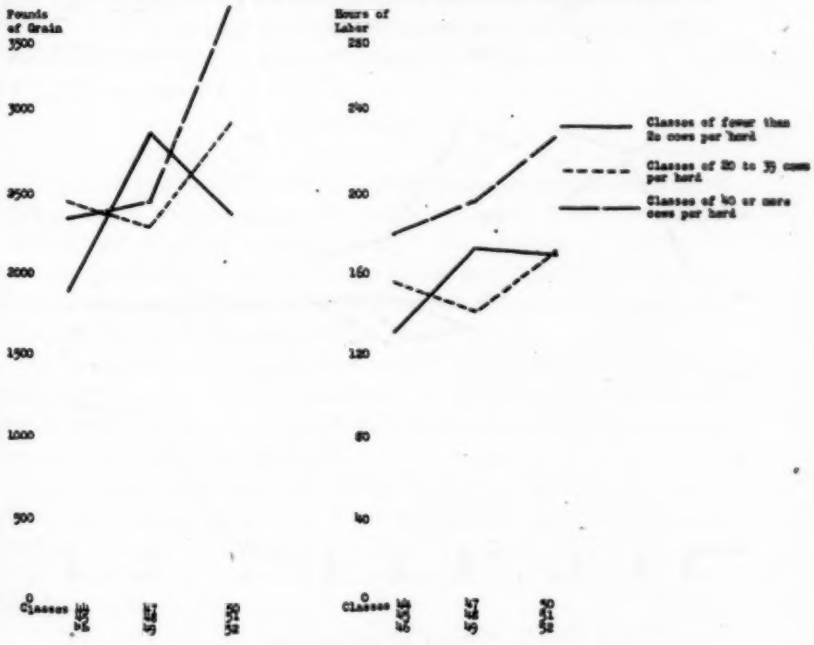
In general it may be said that there is no apparent inverse correlation between the amount of forage and that of grain fed as might be expected, and an increase in the use of grain accompanied an increase in the use of forage and the demand for grain was not diminished by an increase in the use of forage. This may be attributed partly to the capacity of the cows, but it will be seen by comparing the amounts of milk produced, that the heavier feeding does not usually result in a proportionate increase in production, and may be attributed mostly to the interest of the dairyman in his herd and to his liberality in feeding.

Amount of labor used

It may be seen from graph XIV that there is a tendency for the amount of labor used to increase as more forage is fed. This is partly, but not wholly, caused by the longer time required to handle the greater amount of forage.

Graph XIV

Correlation of Amount of Forage fed to Amount of Grain fed and to Amount of Labor per Cow



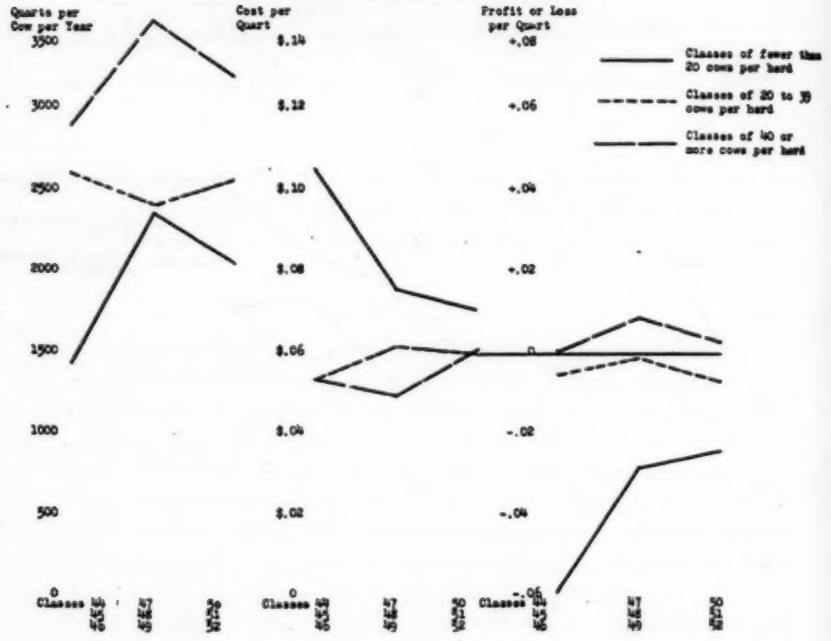
Production

The curves for production in graph XV show that production increases as more forage is fed from classes 44 and 46 to classes 47 and 49. Thereafter, in these cases, the curves show a decline which may be accounted for by inefficient feeding in class 50

and lower productive capacity in class 52. In the group of 20 to 39 cows the production curve at first falls. This may be explained by corresponding dips in the curves for the amounts of grain and of labor used.

Graph XV

Correlation of Amount of Forage fed, to Production and Cost of Production



Cost of production

The cost of production decreases among the small dairies as more forage is used even in class 50 where an average of 3.4 tons of forage points to inefficiency of management. In the groups of larger dairies there is a general tendency for the cost to rise slightly from the classes using but little forage to those using considerable. This increase is due to corresponding increases

in the use of grain and labor, and indeed the added expense from these two items would lead one to expect a greater increase in cost than is apparent here. It is thus suggested, that, had equal amounts of grain and labor been used the cost might even have decreased in these cases rather than increased.

The loss per quart decreased as more forage was fed in the smaller dairies. In the medium-sized and large ones the loss decreased or the profit increased at first but later the profit and loss curves showed a decline, attributable to the increased expense for labor and grain under conditions of diminishing returns, which were shown to exist with regard to these factors.

Summary

Many of the smaller dairies utilize large amounts per cow of cheap bulky roughages of low nutritive value while the larger dairies use forage of a better grade. This makes a comparison on the basis of amount of forage alone unfair, but the following conclusions are believed to be conservative enough to stand with the support of the accompanying data:

1. In dairies making efficient use of the forage fed there is a tendency for the value of the cows to be higher in the dairies using most forage while it will be lower in those which use large amounts of forage inefficiently.

2. More grain is generally fed in the dairies using most forage. Thus, an increase in the use of forage does not generally displace part of the grain fed.

3. There is a tendency for an increase in labor to accompany an increase in the use of forage.

4. The product per cow tends to increase, though not proportionately, as more forage is fed, and at the same time, up to a certain point, the cost of production per quart probably decreases, and the profit per quart will increase if the increase in forage is not accompanied by a corresponding or greater increase in some of the other factors of expense.

Section V. The Relation of Silage to Other Factors

1. Adaption of Data

For this phase of the study the dairies were divided into classes under the same principles as in the three previous phases. The dairies were divided into nine classes as follows:

Division into classes in section V

Class number	Number herds in class	Size of herds	Tons of silage fed
53	17	Fewer than 20 cows	No silage
54	10	20 to 39 cows	
55	1	40 or more cows	
56	8	Fewer than 20 cows	Less than 6 tons
57	12	20 to 39 cows	
58	13	40 or more cows	
59	6	Fewer than 20 cows	6 tons or more
60	8	20 to 39 cows	
61	11	40 or more cows	

It will be seen that there are two sorts of comparisons in this section; one between dairies using no silage and those using silage, and one between dairies using medium and those using large amounts of silage. Into the first group—dairies using no silage—fall the majority of the small dairies, a third of the medium sized ones and only one large dairy. In the second group are found the greatest number both of medium and of large dairies and about one-fourth of the small ones. In the third group occur a few small dairies, a slightly larger portion of the medium sized and nearly half of the large ones. The effect of the size of dairy on the use of silage should be borne in mind. Most of the small dairies are deprived of the use of silage, a feed which is greatly favored by dairymen and which the owners of small dairies would be glad to get, because of their size, which makes it expensive to construct a silo for such a small number of cows. The large dairies are, on the other hand, at an advantage in building silos, as the greater number of cows in them reduces the overhead per cow for the building and maintenance of the silos.

TABLE 5

Section V. Correlations of silage to other factors in milk production. Averages of classes 53 to 61

CLASS NUMBER	NUMBER OF HERDS	NUMBER OF TENANTS	NUMBER OF OWNERS	NUMBER OF COWS IN HERDS	VALUE PER COW	MONTHS OF PASTURAGE	TONS OF SILAGE	COST OF SILAGE	TONS OF FORAGE	POUNDS OF GRAIN	HOURS OF LABOR	QUARTS OF MILK	TOTAL EXPENSE	TOTAL INCOME	COST PER QUART	PRICE PER QUART	PROFIT OR LOSS PER QUART
53	17	6	11	11.0	$71.76	6.1			3.0	2,369	174	1,954	$146.93	$104.31	$0.072	$0.046	—0.026
54	10	4	6	25.4	73.00	6.1			3.1	2,296	135	2,399	133.04	121.71	0.056	0.049	—0.007
55	1	0	1	46.0	65.00	6.5			1.2	1,940	82	1,983	96.95	88.06	0.042	0.036	—0.006
56	8	1	7	14.1	78.75	6.1	4.4	14.00	2.1	2,715	185	2,326	169.73	130.72	0.073	0.048	—0.025
57	12	1	11	27.9	81.25	5.3	4.1	12.46	1.3	2,537	147	2,527	150.76	141.56	0.057	0.052	—0.005
58	13	0	13	61.7	83.23	5.8	4.5	12.96	1.4	2,338	164	3,133	159.21	183.63	0.047	0.055	+0.008
59	6	1	5	11.0	68.33	6.1	6.8	22.96	3.2	2,421	143	2,031	137.03	111.44	0.086	0.048	—0.038
60	8	1	7	27.1	95.00	4.9	7.2	21.47	1.5	2,813	192	3,011	192.38	185.88	0.060	0.057	—0.003
61	11	0	11	66.4	94.54	4.4	7.8	23.72	1.5	2,854	236	3,267	211.01	215.55	0.062	0.061	—0.001

2. CORRELATION OF SILAGE TO OTHER FACTORS

Tenancy

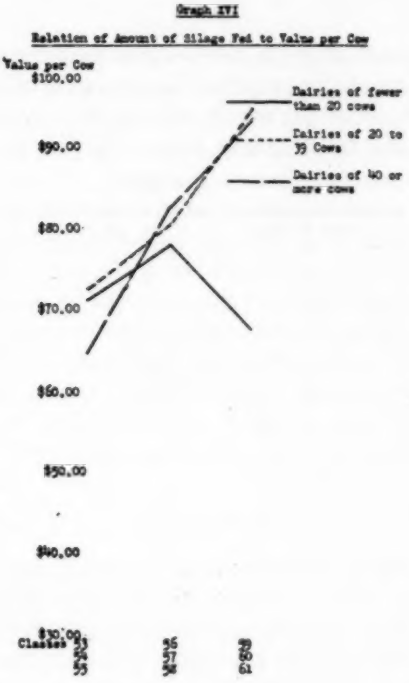
It may be observed from the above table that practically all of the tenant dairies are to be found in the classes using no silage. This is plainly caused by the reluctance of the landlords to go to the expense of building silos on farms which they do not themselves occupy, and for which they feel they would not be sufficiently paid by the increased rent to be derived from the addition of a silo to a rented farm. Furthermore, all four of the tenant farmers who do have the use of a silo are share tenants, and are closely supervised by the landlords. These landlords were actuated by a desire for their own direct gain and not alone by a desire to improve their farms.

Pasturage

The extent to which pasturage was used, decreased as more silage was fed, except in the small dairies where it did not change. In many dairies silage is used as a substitute for pasturage, where it is desired to keep a greater number of cows than can be pastured on the farm. It is possible that the increased cost of production noted below, in dairies using large amounts of silage, results from this substitution and the higher price of silage than of pasturage, but this will not apply to the small dairies, where the amount of pasturage used does not change.

Value per cow

Graph XVI shows that in all classes except class 59 the value per cow rises as more silage is fed, or conversely, that more silage is fed to the better cows, and that a dairyman who is sufficiently wide awake to keep the best cows is also sufficiently up-to-date to make use of what he believes to be the most profitable sorts of feed. In class 59 there is found a group of dairies which, for feed, rely mostly on roughage, and which give their cows too little attention in the form of labor. This, as might be expected, is reflected in the poor condition of the cows and their resulting low market value.



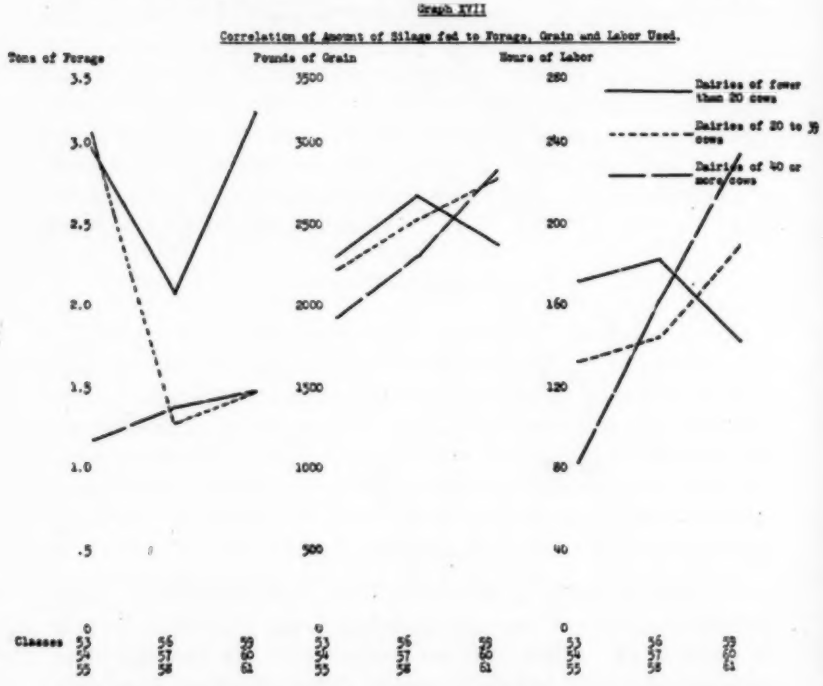
Forage

As silage is partly a substitute for forage, the dairies using medium amounts of silage use much less forage than those feeding no silage at all. Class 55 is an exception to this, but this class is composed of only one dairy, and its data is therefore unreliable for comparison with other classes containing several dairies each.

In dairies in which silage is used as a standard article of feed some dairies will feed sparingly of all sorts of feed, some will try to substitute one sort for another and others will feed either liberally or recklessly of all sorts. The dairies in which silage is substituted for forage are found for the most part in classes 56, 57, and 58, which use the smallest amounts of forage. The third type, those which feed liberally or recklessly, will be found in classes 59, 60, and 61.

Grain

The second part of graph XVII shows that the same liberality in feeding which at first resulted in the use of silage, then in its use in greater quantities, results also in the heavier use of grain coincident to the use of more silage. In this case class 59 is


Graph XVII
Correlation of Amount of Silage fed to Forage, Grain and Labor Used.
Tons of Forage
Pounds of Grain
Hours of Labor
Dairies of fewer than 20 cows
Dairies of 20 to 39 cows
Dairies of 40 or more cows
Classes

again the exception, as noted under "Value per cow" and uses less grain, possibly from penurious principles, instead of more as might be expected from the behavior of the other dairies under like circumstances.

Here a saving by the use of silage which is presumably cheaper than most other feeds is plainly the object of the dairymen. Their mistake is in trying to substitute for concentrates a feed which does not contain the elements of the concentrates.

Labor

The amount of labor used per cow increases slightly from the dairies using no silage to those using moderate amounts. Most of this increase of ten or twelve hours per cow may be regarded as the additional time required to feed the 4 or 4½ tons of silage used in classes 54 and 57. Above the median point, as regards the amount of silage fed, the increase in labor is more rapid and may be regarded as incident to the liberality of the dairymen.

There are two exceptions to the above. The first is class 55, which is composed of only one dairy, which uses only eighty-two hours of labor per cow, the smallest amount used by any dairy in this study. It is, therefore, obviously unfair for comparison. The second exception is class 59, which has been referred to under "Value per cow" and "Grain." Here, the small average amount of labor used is probably inadequate and is reflected in the curve for production.

Production

The production per cow rises consistently as more silage is fed, except in class 59, where it falls slightly. This decrease in class 59 would be expected from the peculiarities of this class noted above. A small amount of labor and of grain fed to cows cannot be expected to give a large production even though the cows may receive plenty of forage and silage.

The increased production in the other classes as more silage is fed, probably resulted from the incidental use of more labor and more grain. But when one considers the conditions of diminishing returns from the use of more of these elements, which was shown to exist in sections I and II of this study, it is doubtful that this increase in production results from these alone. The use of silage may reasonably be inferred to have caused a considerable part, but not all, of this increase.

Cost of production

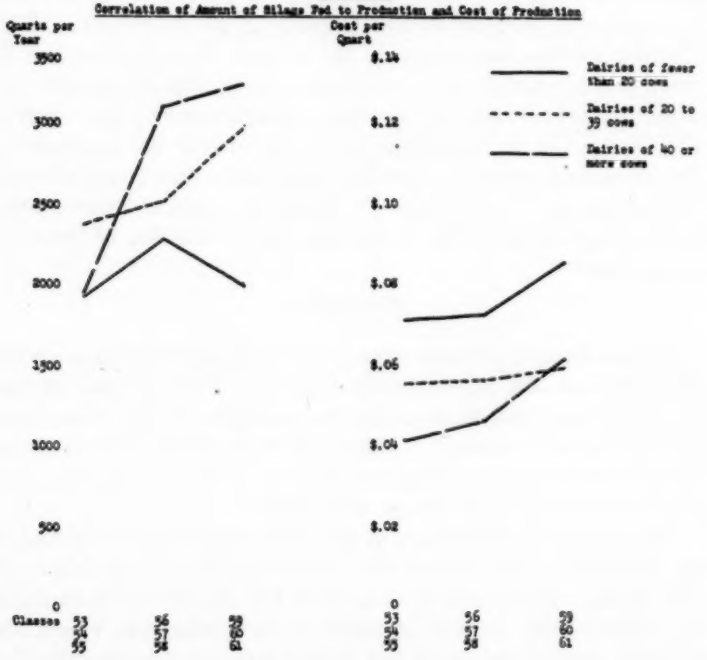
The cost per quart of milk rises slowly as more silage is fed. The increase in cost is less from dairies using no silage to those

using an average of 4.3 tons, than from these latter to dairies using an average of 7.2 tons, indicating that the use of small amounts of silage may be profitable but that diminishing returns set in quickly.

Part of this increase in cost may be and probably is due to a greater outlay for grain and labor and the use of less pasturage, so

Graph XVIII

Correlation of Amount of Silage Fed to Production and Cost of Production



that, allowing for these, the use of silage would appear to affect the cost per quart but slightly, contrary to a widespread belief that silage reduces the cost per quart considerably. The cost per quart might have been reduced, had like amounts of grain and labor been used in all classes, but there is not sufficient evidence at hand either to prove this or to disprove it.. The above is not intended to convey the impression that the use of silage can-

not reduce the cost of milk. Certainly, where silage is used to balance a poorly proportioned ration or to supply needed qualities of succulence or variety, it should reduce the cost of milk. This study purposes to examine the dairy business as it is and not as it might be, and the writer simply desires to state that the dairies using most silage *did not* produce more cheaply than those using little or none, not that they *might not*.

Price received and profit or loss per quart

The price received per quart of milk rises constantly from the dairies using no silage to those using medium amounts and to those using considerable. This would indicate either that the dairies using silage produce milk of better grades, or that their owners succeeded in finding markets which paid higher prices; and both conditions will be seen to exist. The better grades of milk were not produced, except in one case, in dairies using no silage. A silo is regarded as an evidence of progress and prosperity in the community in which these dairies are located. Therefore, it is not surprising that the farmers possessing silos are the most businesslike and are the ones most likely to seek and find the buyers from whom they can obtain the highest prices.

Summary

1. Silage is not generally used on small farms or on tenant farms.
2. More silage is used in dairies composed of cows of high value.
3. The use of silage instead of pasturage is reflected in an increased cost of milk.
4. The use of forage is at first reduced, then increased as at first a little, then considerable, silage is fed.
5. The feeding of more grain and the use of more labor accompanies the increased use of silage.
6. Production is increased by the use of silage, but the cost per quart is also increased partly or wholly by the coincidental use of more grain and labor and of less pasturage.

Section VI. Relation of Value per Cow to Other Factors

1. Adaption of Data

The dairies were divided into classes, as in the preceding sections. The following table will illustrate this division.

Division of dairies into classes in section VI

Class number	Number dairies in class	Size of dairies	Value per cow
62	17	Fewer than 20 cows	Under $75.00
63	9	20 to 39 cows	
64	1	40 or more cows	
65	12	Fewer than 20 cows	$75.00 to $90.00
66	11	20 to 39 cows	
67	11	40 or more cows	
68	2	Fewer than 20 cows	$90.00 or more
69	10	20 to 39 cows	
70	13	40 or more cows	

It will be observed that most of the small dairies fall into the first group, that of the cheapest cows. Most of the medium sized dairies fall into the second group and most of the large ones into the third. Only one large dairy is composed of cows valued at less than $75 apiece, and only two small dairies are valued at $90 per cow or more.

In this phase of the study, the rule[2] relating to value per cow should be borne in mind. The value here referred to is the value for which the cows in question would sell for dairy cows in the section where this study was made. It, therefore, represents an approximate measure of their productive capacity, superimposed upon their market value for beef, as nearly as it could be judged by the farmers owning the cows and those who would be the purchasers if the cows were sold. These persons would be the ones to fix the price if the cows were sold. If this value were the true measure of the cows' productivity, it should be proportionate to their production. And from the averages of the different

[2] Rule 2, p. 2.

classes, it will be observed that, allowing for natural and unavoidable mistakes in appraisal, this is approximately the case.

2. RELATION OF VALUE PER COW TO OTHER FACTORS

Investment in buildings and equipment

As mentioned in section I, the buildings on most of the farms, included in this study, were older than the system of dairying in practice. For this reason no definite correlation of investment in buildings to value per cow appears to exist.

The investment in equipment varies widely from class to class, but no correlation to value per cow is obvious, somewhat contrary to expectations.

Pasturage and silage

In comparing the extent to which pasturage and silage are used, it is evident that there is a tendency to feed the more valuable herds more silage, and to pasture them less, than the less valuable cows. This means that the farmers who keep more productive cows have a greater proportionate investment in the cows than in land and are, therefore, obliged to use more intensive and more indirect methods of feeding. It also means that the dairyman, who, by careful and expert breeding, has built up a herd of highly productive cows, is more likely to keep his cows in the stable a greater part of the time and give them more personal attention. Perhaps this is simply because he likes to work around cows. If the cows are to be kept in the stable most of the time, they must be fed a substitute for pasturage, for which purpose silage is the most generally used of all feeds. This correlation also suggests from the opposite point of view that, when the cows are kept in the stable most of the time and when the dairyman spends most of his time around them, he becomes best acquainted with the performance and peculiarities of each individual cow. He is thus better able to discriminate in breeding the cows which are to be kept, and in picking out those which are to be disposed of.

TABLE 6

Section VI. Correlation of value per cow to other factors in milk production. Averages of classes 62 to 70

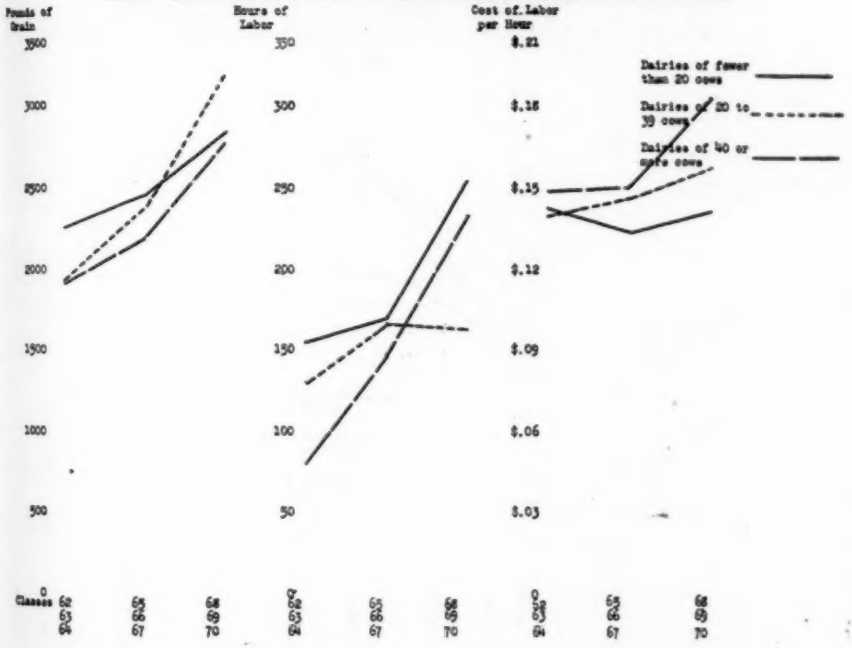
CLASS NUMBER	NUMBER OF DAIRIES IN CLASS	NUMBER OF COWS IN HERD	VALUE PER COW	INVESTMENT IN BUILDING	INVESTMENT IN EQUIPMENT	MONTHS OF PASTURAGE	TONS OF SILAGE	TONS OF SOILAGE AND ROOTS	TONS OF FORAGE	POUNDS OF GRAIN	HOURS OF LABOR	COST PER HOUR	QUARTS MILK PER YEAR	TOTAL EXPENSE	TOTAL INCOME	COST PER QUART	PRICE PER QUART	PROFIT OR LOSS PER QUART
62	17	11.5	$65.88	$122.60	$11.58	6.2	2.4	0.3	3.2	2,293	159	$0.144	1,890	$150.02	$98.56	$0.079	$0.046	$−0.033
63	9	25.1	63.77	102.39	7.83	5.7	1.6	0.002	3.0	1,974	133	0.139	2,033	130.69	113.74	0.062	0.052	−0.010
64	1	46.0	65.00	76.08	3.85	6.5			1.2	1,940	82	0.150	1,983	96.95	88.06	0.042	0.036	−0.006
65	12	11.2	79.58	151.66	14.66	5.9	2.6	0.3	2.2	2,483	172	0.135	2,296	163.54	130.96	0.071	0.050	−0.021
66	11	28.0	81.82	118.11	13.98	3.0	4.2	0.3	1.5	2,420	171	0.148	2,591	157.21	147.39	0.059	0.055	−0.004
67	11	54.7	80.45	95.45	11.16	5.8	5.2	0.1	1.4	2,206	151	0.151	2,818	169.11	150.45	0.050	0.048	−0.002
68	2	17.5	92.50	144.95	8.12	6.2	4.0		2.5	2,878	257	0.140	2,353	238.04	121.80	0.075	0.046	−0.029
69	10	27.1	98.00	116.10	15.46	5.5	4.8	0.3	1.5	3,237	165	0.159	3,222	181.91	183.03	0.053	0.053	+0.000
70	13	72.5	96.15	187.39	17.33	4.4	6.6	0.6	1.5	2,804	236	0.185	3,511	210.05	239.25	0.057	0.065	+0.008

Forage and grain fed

There is a general, though poorly defined, tendency for less forage to be fed in the classes of more valuable cows. This tendency is obscured by classes 64 and 68, which contain only one and two dairies respectively, and may therefore be expected to show irregular tendencies.

Graph XII

Relation of Value per Cow to Amount of Grain and of Labor Used and to Cost of Labor per Hour.

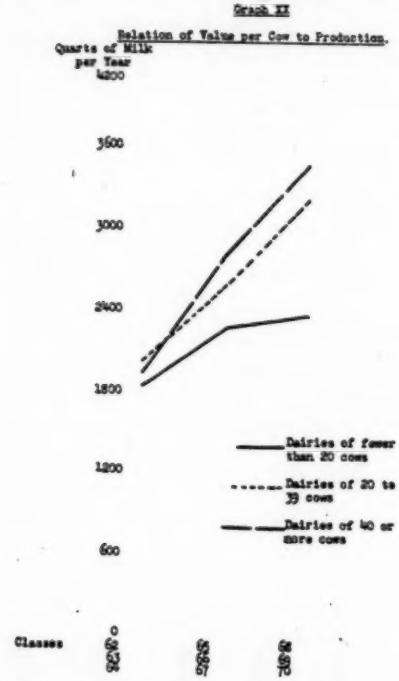


The amount of grain fed increases with the value of the cows as is illustrated by graph XIX and indicates that value is largely conditioned on the capacity of the cows, some being able to make use of greater quantities of feed than others. The value of a cow may be said to result as truly from her capacity to transform raw material in the form of feed into her product, which is milk,

as the value of a factory to result from its capacity to turn cotton into cloth, or steel bars into nails.

Labor

The amount of labor used per cow increased with the value of the cow. Slightly more labor is required to feed and handle the



milk of a cow of large capacity than to perform the same operations for one of low capacity, but the most of this increase in labor may be attributed to the greater conscious effort to take the best possible care of the cows of a productive dairy, as contrasted to the general lack of interest usually found accompanying poor cows. The more productive dairies, are naturally the more prosperous, therefore it need occasion no surprise to find that the

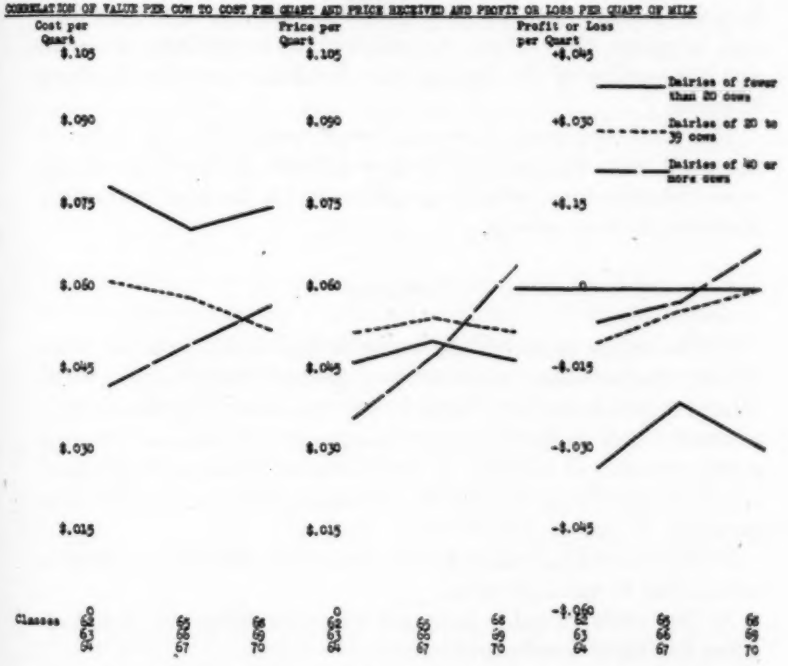
labor used in dairies of greater value per cow is more highly paid than that in herds of low value and low productivity.

Cost per quart and price per quart

The curves for the cost per quart of milk, as shown in graph XXI, exhibit conflicting tendencies, showing that other factors than the productive capacity of the cows are at work in these dairies.

Graph XXI

CORRELATION OF VALUE PER COW TO COST PER QUART AND PRICE RECEIVED AND PROFIT OR LOSS PER QUART OF MILK



The price received per quart tends to rise from the classes containing the cheapest cows to those containing cows of medium value. From this it would seem that the farmers with cows of fairly good type and capacity are better business men and make more of an effort to secure high prices for their products than those who keep the poorest cows.

After the median point is reached, two contrary tendencies appear. In the large dairies, the price obtained per quart continues to rise with the value of the cows. This is due to the sale by these dairies of the higher grades of milk. But in the small and medium sized dairies the price obtained for the milk in the most valuable dairies is less than that obtained in the dairies of medium value. This suggests that the farmers who keep the most valuable cows, are more deeply interested in the cows than in their product. Therefore, they do not seek nor do they obtain the highest price for their product. Here is a striking fact, and it shows the extent to which the psychologic makeup and personality of the farmer may dominate over his business interests.

The profit per quart, however, tends to rise with the value of the cows, showing that the greater natural productivity of the more valuable cows more than makes up for the poor marketing methods of their owners.

Summary

1. The value at which the cows in the dairies studied were held by their owners, and which was proportionate to that which other farmers would be willing to pay for them, supplies a fairly accurate index to their productive capacity, if taken as covering a large number of dairies. In individual cases accurate appraisal is not always obtained, but the variations from the normal tend generally to cancel each other.

2. Investment in buildings and equipment showed no definite correlation to value of cows.

3. The more valuable cows are fed more silage and are pastured less than the cheaper ones.

4. There is a general tendency to feed less forage, and a well defined tendency to feed more grain to the more valuable cows, showing the capacity of the more valuable cows to make use of greater quantities of feed, especially grain.

5. More care and labor is expended on the more valuable than on the cheaper cows.

6. The cost per quart of milk exhibited conflicting tendencies, showing that other factors than the natural productivity of the cows exert an influence on it.

7. Except in the case of dairies producing the higher grades of milk, there is a tendency for the dairymen owning the most valuable cows to accept lower prices for their products than those owning the cows of medium value. This is a result of a greater interest among these farmers, in the care of their cows than in the profit from them.

8. The poor marketing methods among the farmers owning the most valuable cows were overbalanced by their greater productivity of these cows, which resulted in a greater profit per quart from their milk than from that of the cheaper cows.

Section VII. The Relation of Tenantry to the Factors in Milk Production

1. Adaption of data

Since there were no tenant dairies among those of 40 or more cows to compare to the owner dairies of that size it was not necessary to include the largest dairies in this section. This left 61 dairies, of which 14 were operated by tenants and the rest by their owners. These were divided into four classes as follow:

Division of dairies into classes in section VII

CLASS NUMBER	NUMBER OF DAIRIES	KIND OF DAIRIES	SIZE OF DAIRIES
71	23	Owner	Fewer than 20 cows
72	8	Tenant	
73	24	Owner	20 to 39 cows
74	6	Tenant	

While the owner dairies outnumber the tenant dairies by 3 to 1 or 4 to 1, there are still enough dairies in each class to provide reliable averages for comparison.

The tenants in the neighborhood where this study was made are, on an average, of lower economic status than the farm owners, and, in most cases, tenancy is simply a step in the progress

of these men to farm ownership. Indeed, at least one of the tenants in classes 72 and 74 has become a farm owner, to the writer's knowledge, since these data were collected, and probably others of whom he does not know. They are, for the most part, steady, industrious farmers who remain on the same farms for an average of six or eight years, seldom moving unless they can better their condition. Thus, it will be seen that these are not of the "floating tenant" type, and a comparison with the farm owners is not unfair. The principal difference between the owner and tenant dairymen in this study is that the latter have a greater incentive to saving and are not so liberal in their expenditures, and that their farm buildings are likely not to be in such good condition since the landlords are often reluctant to spend money for improvements unless assured of a certain return.

2. RELATION OF TENANTRY TO THE FACTORS IN MILK PRODUCTION

Value per cow

This value varied very little from class to class, except in class 73 where it was higher than in any other.

Investment in buildings and equipment

The investment in buildings was higher in both cases in the owner dairies than in the tenant, showing the tendency on the part of the landlords to spend as little money on their rented farms as possible. This tendency is plainly evident, despite the age of the buildings on most of the farms, as has been mentioned above in section I.

The investment in equipment varied very little, being slightly higher in class 71 than in class 72, and higher in class 74 than in class 73.

Tons of forage and amount of grain fed

The amount of forage fed varied, but not with tenancy. More forage was used per cow by tenants in the group of small dairies, and by the owners among the larger dairies.

TABLE 7

Section VII. Relation of tenantry to the factors in milk production. Averages of classes 71 to 74

CLASS NUMBER	NUMBER OF HERDS IN CLASS	NUMBER OF COWS IN HERDS	VALUE PER COW	INVESTMENT IN BUILDING	INVESTMENT IN EQUIPMENT	TONS OF FORAGE	POUNDS OF GRAIN	HOURS OF LABOR	COST PER HOUR	QUARTS MILK PER YEAR	TOTAL EXPENSE	TOTAL INCOME	COST PER QUART	PRICE RECEIVED PER QUART	PROFIT OR LOSS PER QUART	NUMBER OF DAIRIES SELLING		
																Butter	Milk	"A" Milk
71	23	11.2	$72.82	$138.94	$13.25	2.6	3,489	173	$0.143	2,119	$158.49	$115.09	$0.075	$0.047	$−0.028	7	16	0
72	8	12.1	73.12	124.54	10.53	3.5	2,410	162	0.140	1,963	150.46	104.18	0.076	0.047	−0.029	3	4	0
73	24	26.0	84.37	124.05	11.01	2.1	2,601	163	0.153	2,746	165.43	158.49	0.058	0.055	−0.003	1	18	5
74	6	28.3	71.66	71.67	12.44	1.5	2,387	135	0.145	2,170	125.39	108.92	0.056	0.046	−0.010	1	5	0

The amount of grain used was, however, decidedly affected by tenantry. An average of over 900 pounds more grain was used per cow in the owner dairies of small size, and of over 200 pounds more in the medium sized dairies.

Labor

The owner dairies used an average of eleven hours of labor per cow more than the tenants in the classes of small dairies, and twenty-eight hours more in the medium sized ones. The owners also paid a slightly higher wage than the tenants.

Production

The production per cow is slightly higher among the owners than among the tenants in the group of small dairies, among the medium sized dairies it is decidedly higher. This is probably due to the greater amount of care and of concentrates given each cow by the farm owners, though in class 73, it is probably affected also by the greater productive capacity of the cows, as suggested by their higher average value. But that general and perhaps excessive, thrift among the tenants was also a factor, is strongly suggested by the figures for total expense and total income.

Cost of production

Between owner and tenant dairies of the same size the cost of production varies but little, being slightly higher in one case and slightly lower in the other. The profit or loss per quart slightly favors the owner dairies.

Summary

It is apparent from the preceding that the principal difference between owner and tenant dairies is to be found in the greater incentive to saving and less liberality in expenditures in the latter class. There is also an obvious tendency to the spending of as little money as possible on rented farms by the landlord, so that between the landlord and the tenant, the cows may sometimes suffer from excessive thrift. All the differences discovered,

thus far, between tenant and owner dairies may be traced to one or both of the above principles, and although the production, cost of production, and profit or loss per quart of milk generally favor the dairy operated by the farm owner, such differences are slight, and in individual cases may be overcome altogether.

Section VIII. Production

1. Adaption of data

In each of the preceding sections, production, in terms of the number of quarts of milk produced per cow per year, has provided one of the principal factors for comparison, and a measure of the effects on the dairy business of each of the other factors. Thus, since production has been compared to each of the other factors, it might be argued that this section is unnecessary. But the following paragraphs will, it is believed, show some tendencies which were obscured in the earlier sections, and some which did not show themselves at all.

In this section the same division, as to size, which was used in the earlier ones has been retained. Each of these three groups has been subdivided into three according to production in such a way that each of the three divisions as to production would contain nearly equal numbers of dairies. These three groups may be considered as groups of low, medium, and high production.

Division of dairies into classes in section VIII

CLASS NUMBER	NUMBER OF HERDS IN CLASS	SIZE OF DAIRIES	PRODUCTION PER COW
75	18	Fewer than 20 cows	Less than 2200 quarts
76	8	20 to 39 cows	
77	3	40 or more cows	
78	9	Fewer than 20 cows	2200 to 2800 quarts
79	11	20 to 39 cows	
80	5	40 or more cows	
81	4	Fewer than 20 cows	2800 quarts or more
82	11	20 to 39 cows	
83	17	40 or more cows	

It will be observed that the majority of the small sized dairies fall in the groups of low production, that the medium sized herds are mostly in the groups of medium and high production, while the majority of the large dairies are in the group of high production.

2. RELATION OF PRODUCTION TO OTHER FACTORS

Value per cow

There appears to be a general, though poorly defined, tendency for the investment in buildings to be higher in dairies with the highest production per cow, though it is not necessarily lowest in dairies with the lowest production.

In the medium sized and large dairies there is a well defined tendency for the investment in equipment to increase with production. In the small dairies, however, the opposite tendency appears, due probably to coincidence in class 81 in which there are but four dairies. In class 77 which contains only three dairies it is also due apparently to coincidence.

Pasturage, silage, and forage

The extent to which pasturage was used decreased slightly as production increased. At the same time, the amount of silage used increased rapidly. This suggests the possibility of increasing production by keeping the cows under artificial conditions and feeding heavily a "grass substitute" instead of forcing the cows to forage round for the major part of their feed.

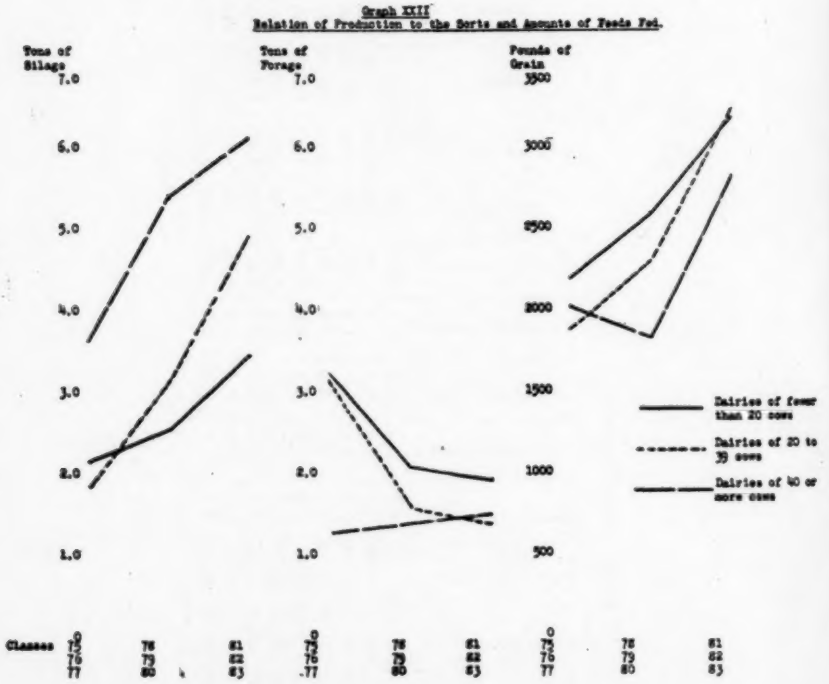
At the same time, the amount of dry forage evinced a strange tendency to decrease as production increased, except in the large dairies where there was a slight increase. This general decrease in the use of forage resulted first from the use of a better quality of forage in the herds of high production, that is, fewer of the highly productive than of the poorly productive dairies depended on their cows to clean up coarse and unsalable roughages. A second cause was the partial substitution of silage for forage as suggested in section V. In the earlier sections, it was

TABLE 8

Section VIII. Production. Averages of classes 75 to 83

CLASS NUMBER	NUMBER OF HERDS IN CLASS	NUMBER OF COWS IN HERD	VALUE PER COW	INVESTMENT IN BUILDING	INVESTMENT IN EQUIPMENT	MONTHS OF PASTURAGE	TONS OF SILAGE	TONS OF SOILAGE AND ROOTS	TONS OF FORAGE	POUNDS OF GRAIN	HOURS OF LABOR	QUARTS OF MILK PER YEAR	TOTAL EXPENSE	TOTAL INCOME	COST PER QUART	PRICE RECEIVED PER QUART	PROFIT OR LOSS PER QUART
75	18	10.7	$71.11	$132.05	$13.72	6.2	2.2	0.2	3.3	2,217	166	1,713	$153.66	$93.63	$0.087	$0.046	$−0.041
76	8	25.4	66.25	124.81	6.98	5.1	1.9	0.1	3.2	1,901	123	1,857	130.03	114.52	0.065	0.055	−0.010
77	3	52.3	71.66	91.18	3.51	5.3	3.7		1.3	2,054	91	1,894	123.28	96.21	0.057	0.042	−0.015
78	9	13.1	74.44	131.20	12.35	6.0	2.6	0.2	2.1	2,623	181	2,914	158.99	133.33	0.059	0.048	−0.011
79	11	27.6	78.73	114.62	13.01	5.8	3.2	0.1	1.6	2,317	160	2,504	146.02	138.34	0.055	0.052	−0.003
80	5	50.6	81.00	76.59	12.70	6.1	5.5	0.2	1.4	1,849	160	2,710	156.30	162.67	0.054	0.056	+0.002
81	4	13.7	77.50	158.58	7.72	5.9	3.5	0.5	2.0	3,254	169	2,946	175.52	152.33	0.056	0.048	−0.008
82	11	26.2	96.27	116.85	16.35	5.3	5.0	0.5	1.4	3,277	181	3,323	188.75	189.29	0.054	0.052	−0.002
83	17	68.7	92.35	165.06	16.34	4.8	6.2	0.5	1.5	2,842	202	3,495	196.26	220.67	0.053	0.060	+0.007

due to an unbalancing of the proportions most desirable in the use of these factors. If the latter alternative obtained, the use of simultaneous increments in this phase of the study might prevent a corresponding increase in cost or even reduce it. The latter is apparently the right explanation, although, in the earlier sections, the increase in the use of each factor was accompanied by some increase in most of the other factors.



Here it may be observed that, as the production per cow increases, the cost per quart decreases at first rapidly then more slowly. This suggests that had sufficient data been accumulated to permit division into a greater number of classes, some of which would have been composed of dairies producing more milk per cow than the average of the group of highest production in this

section, the point might have been found where further increases in production would have cost more per quart instead of less. There is little doubt that this condition exists in any given herd, and the greater productivity which is here coupled with low cost is probably a result of difference in productive capacity of the cows rather than the use of different quantities of each factor of production, in the proper ratio.

Price per quart

Graph XXIV shows that in the large dairies the average price received per quart for milk is greater in the more productive than in the less productive herds. This, however, is due mostly to the sale of the higher grades of milk by the more productive herds. In the small and medium sized dairies, the price per quart shows but little tendency to change with production.

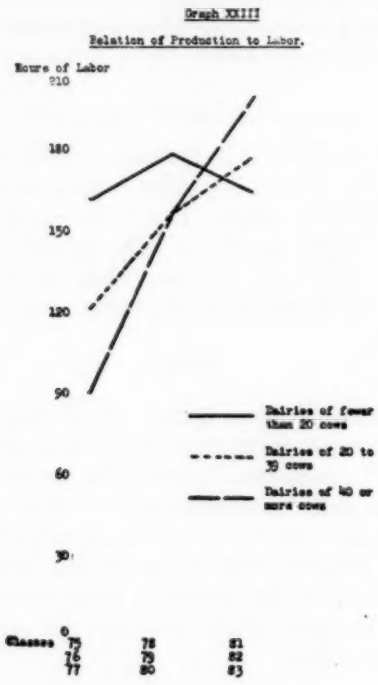
Grain

It may be observed from graph XXII that the amount of grain used rises with production in all cases except class 80 in which the need is, perhaps reduced by the use of more pasturage. The use of more grain, accompanied by a *corresponding* increase in the other factors of production, resulted usually in a more favorable ratio of grain to milk as production increased. This is sharply in contrast to the condition found in section II, where the productive capacity of the cows did not play so important a part as in this section.

Labor

Graph XXIII shows that the amount of labor used per cow increases with production except in class 81. This increase, however, exceeds in only one case, and then very slightly, the upper limit of the median group of section I. It will be remembered that it was within the limits of this group that labor was found to be most productive. Within this section, however, is to be found a more or less indiscriminate mixture of the dairies which made up section I, and averages of different sorts of dairies

are of little value. It is worth noting, however, that the group of most productive dairies uses an average amount of labor which is very close to the point of maximum returns for that commodity as discovered in section I.



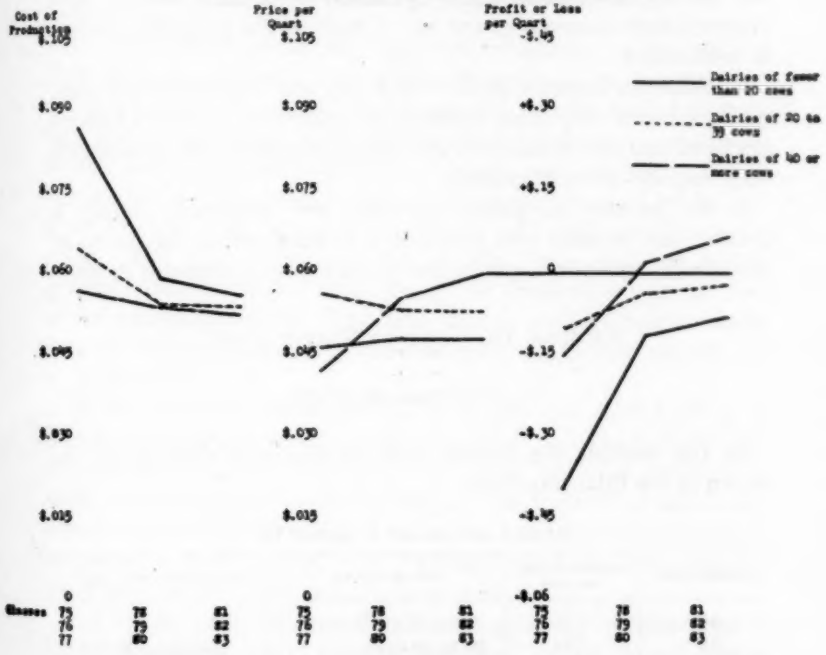
Cost of production

Since it was found in the earlier sections of this study, that an increase in the use of grain, silage, or labor, especially if this increase of one factor were unaccompanied by a corresponding increase in any other, usually increased the cost of production, it would be expected either that an increase in all three as occurs here, would produce a threefold increase in the cost of produc-

tion. Or that, in the earlier sections it might have been due to an unbalancing of the proportions most desirable in the use of these factors, in which case the use of simultaneous increments in this phase of the study might prevent a corresponding increase in cost or even reduce it. The latter is apparently the true explanation, although in the earlier sections, the increase in the use of

Graph XXIV

Relation of Production to Cost of Production and Price per Quart.



each factor *was* accompanied by some increase in most of the other factors.

Price per quart

Graph XXIV shows that in the large dairies the average price received per quart for milk is greater in the more productive than in the least productive herds. This, however, is due mostly to the sale of certified milk, "A" milk, and "Nursery" milk by the

more productive herds. In the small and medium sized dairies the price per quart shows little tendency to change.

Summary

From the foregoing it is evident that:

1. The general increase in production from group to group in this section accompanies and is caused by a simultaneous and proportionate increase in the use of each of the principal factors in production.

2. While an increase in the use of any one isolated factor may result in but a very small increase in production, if all the factors are increased simultaneously and proportionately the production may respond proportionately.

3. An increase in production does not necessarily imply a greater cost for each new increment, at least within the limits of this study, and may even be accompanied by a decrease in cost.

Section IX. Cost of Production

1. Adaption of Data

In this section the dairies were divided into nine classes as shown in the following table.

Division into classes in section IX

Class number	Number herds in class	Size of dairies	Cost per quart of milk
84	3	Fewer than 20 cows	Less than $0.050
85	12	20 to 39 cows	
86	13	40 or more cows	
87	11	Fewer than 20 cows	$0.050 to $0.064
88	10	20 to 39 cows	
89	5	40 or more cows	
90	17	Fewer than 20 cows	$0.065 or more
91	8	20 to 39 cows	
92	7	40 or more cows	

The points of division of classes as to cost per quart are arbitrarily adopted on exactly the same principles as those mentioned in section VIII. The points adopted divide the total number into three groups containing approximately equal numbers of dairies. It may be observed that the majority of the small dairies fall into the group producing milk at the highest cost per quart, while the greatest number of both medium and large sized dairies are to be found in the group producing milk at the lowest cost.

It should be borne in mind in the consideration of this section that there are different grades of milk produced in the groups of different size. The small dairies produce market milk and butter, and of these, the butter producing dairies are found mostly in the class producing milk at the highest cost per quart, with a few in the medium class. Most of the medium sized herds produce market milk but a few produce "A" milk or "Nursery" milk. The two distinct grades—market milk and the higher grades—are distributed throughout the three classes as to cost about proportionately. The large dairies produce market milk, and the higher grades are produced generally though not always at higher cost.

Butter making dairies are likely to produce their milk at a higher cost than those selling the milk as such. The butter making dairies included in this study seem to be less efficient than the milk producing ones, probably because the method of sale is less direct and there is more likelihood of the farmers deceiving themselves as to profit or loss, or of confusing cost factors which intervene between the cow and the consumer.

"A" milk and "Nursery" milk are generally produced at a higher cost than market milk, and certified milk is almost always produced at a higher cost.

There are good and valid reasons, in the form of expenses necessary to the production of a better product, why the highest grades of milk should cost more than market milk. But there are no such reasons for the high cost of the milk from which butter is made, especially since the sale of the product in this form is usually less profitable than its sale as market milk. The respon-

sibility for the high cost of milk in these dairies must therefore be placed on the composition and the management of the dairies.

2. RELATION OF THE COST OF PRODUCTION TO THE FACTORS OF MILK PRODUCTION

Value per cow

It will be seen from graph XXV that the milk produced at the highest cost is produced by the cheapest cows, except in the large dairies where the milk produced at a high cost per quart is of a higher quality than that produced at a low cost. As might be

Graph XIV

Relation of Cost of Production to Value of Cows.

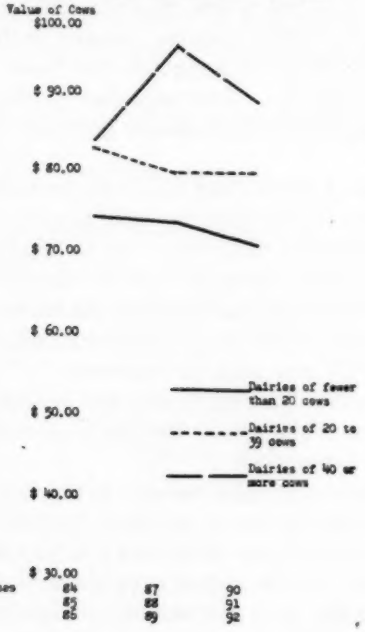


TABLE 9

Section IX. Cost of production. Averages of classes 84 to 92

CLASS NUMBER	NUMBER OF HERDS IN CLASS	NUMBER OF COWS IN HERD	VALUE PER COW	MONTHS OF PASTURAGE	TONS OF SILAGE	TONS OF SOILAGE AND ROOTS	TONS OF FORAGE	POUNDS OF GRAIN	PER CENT OF GRAIN FURNISHED	HOURS OF LABOR	COST OF LABOR PER HOUR	QUARTS MILK PER YEAR	TOTAL EXPENSE	TOTAL INCOME	COST PER QUART	PRICE PER QUART	PROFIT OR LOSS PER QUART
84	3	18.0	$75.00	6.5	1.3	0.4	1.9	3,215	52	141	$0.158	2,615	$127.84	$133.92	$0.041	$0.042	$+0.001
85	12	29.2	83.75	5.8	2.8	0.1	1.4	2,490	60	144	0.148	3,031	145.26	155.24	0.045	0.048	+0.003
86	13	54.7	84.23	5.8	4.4	0.1	1.4	2,309	77	151	0.153	3,165	156.22	168.97	0.042	0.046	+0.004
87	11	13.0	74.54	5.9	2.2	0.1	3.0	2,007	57	157	0.138	2,383	147.26	120.05	0.058	0.047	−0.011
88	10	25.5	80.50	5.7	3.3	0.2	3.0	2,530	71	132	0.151	2,345	151.82	132.14	0.060	0.052	−0.008
89	5	74.4	96.00	3.1	7.0	1.0	1.4	3,114	91	224	0.189	3,300	197.95	201.91	0.055	0.055	+0.002
90	17	9.9	71.41	6.1	2.8	0.3	2.8	2,635	48	185	0.139	1,785	170.32	104.26	0.093	0.048	−0.045
91	8	25.0	80.62	4.2	4.8	0.5	1.5	2,697	61	212	0.158	2,386	183.03	161.37	0.074	0.062	−0.012
92	7	71.9	89.29	5.3	7.3	0.4	1.5	2,591	81	247	0.180	2,956	223.89	249.62	0.072	0.077	+0.005

expected, the milk of high quality is produced in dairies keeping the best and most valuable cows.

Thus, where milk of uniform grade and quality is concerned, the more expensive cows may be expected to produce it more cheaply than the cheaper ones, which were shown earlier to have a lower productive capacity.

Pasturage, silage and forage

It may be observed from table IX that there is a general though irregular tendency for the use of pasturage to diminish as the cost of milk increases, or conversely, for the cost of producing milk to rise as the use of pasturage is diminished.

Simultaneous with the decrease in the use of pasturage is an increase in the use of silage. The use of forage shows a peculiar tendency to be greatest in the dairies producing milk at medium cost. The relation of silage to cost of production here agrees with the conclusions in this regard in section V. The causes for the variation in use of forage are not so plain. It is simply shown that the dairies using most forage are able to produce milk at a medium cost, except in the case of the small dairies where the use of great quantities of forage under a system of doubtful efficiency was more likely to accompany a high cost of production than a low one.

Grain

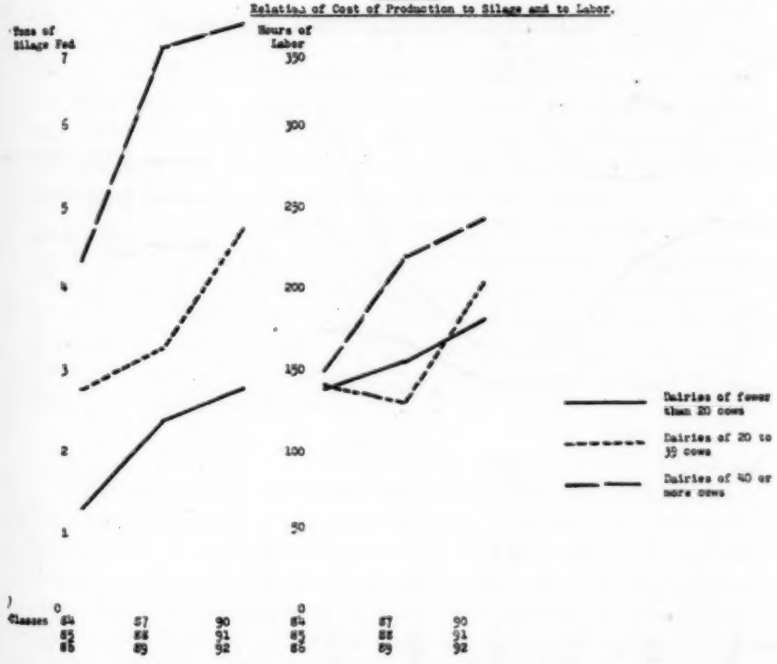
No definite correlation between amount of grain fed and cost of production could be discovered, though an irregular variation in the use of grain did exist. This would suggest that it is the system under which the grain is fed, and the ability of the dairyman to judge the capacity of his cows and to act intelligently on his knowledge, which counts for more than the amount of grain or forage fed. The same may be said of the proportion of grain purchased, which in most classes varied from zero to 100 per cent.

Labor

It may be observed from graph XXVI that the dairies producing milk at the highest cost use the most labor, and, except in the case of the large dairies producing high grades of milk, there is but little difference in the average price per hour paid for labor.

Graph XXVI

Relation of Cost of Production to Silage and to Labor.

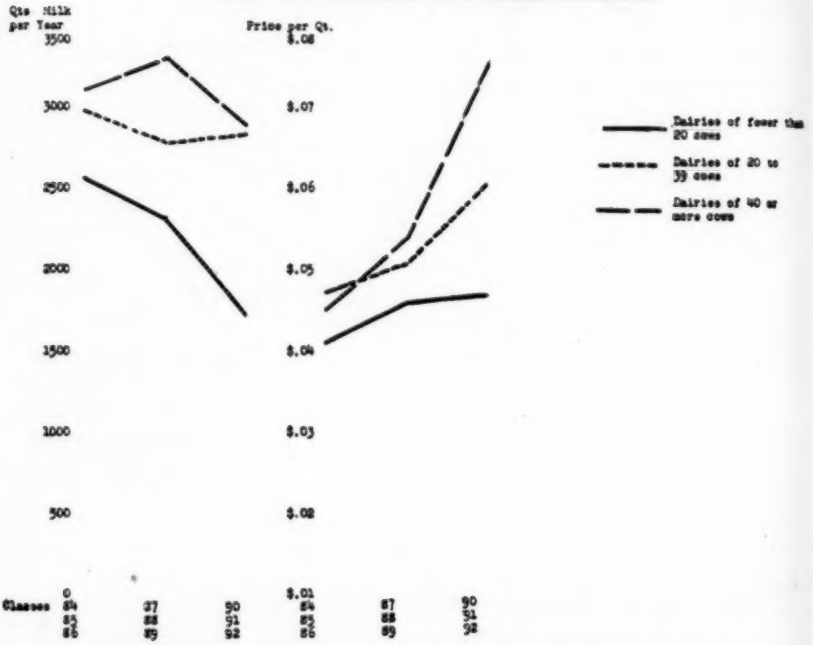


In view of the next factor—the amount of milk produced—it must be concluded that the dairies producing milk at the lowest cost are those which use labor most efficiently, and are therefore able to get along with the smallest amounts of it. The average amount of labor used in any class seems here to have an inverse relationship to the efficiency with which it is used, as distinguished from the purely subjective sense in which "amount of labor" was used in section I.

Production

From graph XXVII it will be seen that production usually decreases as the cost per quart increases. It will be remembered that the increase in cost of milk from group to group has been found to be accompanied by a decrease in value per cow, the substitution of silage for pasturage, the use of more labor, and ap-

Graph XXVII
Relation of Cost of Production to Production, and Price per Quart.



parently its less efficient use. Thus, it may be inferred that, in efficient dairies, the production of more milk may be accompanied by its cheaper production if such of the changes mentioned above as make for the more expensive production of the milk be prevented. Where the production of large quantities of milk and cheap production are found, both may be attributed to the same factors of efficiency.

Price and profit per quart

Graph XXVII shows that the price obtained per quart for milk is higher in the dairies producing it at a high cost than in those producing it more cheaply. It may safely be assumed that, taken on an average, the farmer either knows, or else feels instinctively, and with a considerable degree of accuracy, whether he is making or losing money. It may also be assumed, and the assumption is supported by the data, that they who are the heavier losers will make the greatest efforts to get higher prices for their products, while they who are making a profit or losing but little will more easily be satisfied with the prices they are already receiving and hence are not likely to be the ones who seek farthest for buyers who will pay the highest prices.

If the column "Profit or loss per quart" be compared with the column "Price per quart," it will be found that, though they, who produce milk at the highest cost, are able to obtain somewhat higher prices for it, the increase in price lags behind the increase in cost, excepting in the dairies producing the higher grades of milk. The milk produced at the lowest cost per quart thus pays the greatest profit.

Summary

"Cost per quart" like "Production" is not a simple factor like "Amount of labor," "Silage," "Forage," "Grain," etc., but is a complex of all the factors in the cost of production. In considering a product of uniform grade and quality, the cost per quart is more nearly a satisfactory measure of efficiency of production than any other factor. Since different systems of management and feeding may be best under different conditions, it is to be expected that only those factors which vary but little between different systems of management, should show well defined correlations to the cost per quart, and that the others should be more or less obscured by cross currents among other factors. It is safe, however, to draw the following conclusions:

1. The cost per quart is lower in dairies composed of high priced and highly productive cows than in those composed of cheap and poorly productive ones.

2. The substitution of silage for pasturage was observed to accompany an increasing cost of production.

3. The dairies producing milk most cheaply are enabled by efficient management to use less labor than those producing milk at a higher cost.

4. The same factors which make for cheapness of production through efficiency of system and of management also make for greater production.

5. The dairymen who lose most heavily on their products, succeed in partially offsetting this loss by finding buyers who will pay the highest prices for the products in question. This increase in price is, however, insufficient to overcome the higher cost of production and they who produce milk at the highest cost suffer the heaviest losses per quart.

Conclusion

In conclusion, the writer feels that he must recognize the inadequacy of such a study as this of so big and so complex a problem as the business side of dairying.

In the first place, the data is, beyond doubt, insufficient for a complete study. For a satisfactory study, data should have been obtained from two to three times as many dairies as are included here. That more data were not obtained is to be attributed to limited time and restricted financial provisions. In regard to the very large dairies, however, those of 75 or more cows, it is but fair to remark that data were obtained from all such dairies the writer could find in the district where the data were collected—New Castle County, Delaware, and Chester County, and part of Delaware County, Pennsylvania. To have obtained data from a larger number of big dairies, it would have been necessary to go into other districts where different conditions might have complicated the study.

The investigation has been greatly complicated by cross currents and counterbalancing tendencies among the factors. These have frequently obscured the correlations, and it is possible that in some cases they have even led to wrong conclusions. The

writer has constantly watched for these tendencies and has called attention to them, where they were found.

The study has been limited in scope by the inability of the writer to discover any satisfactory method of measuring some factors, such as, for instance, management in dairies which employ no manager, but which are managed by the owner.

Another source of complication was the fact that many of the dairies, especially the smaller ones, were organized to fit the farms on which they were found and therefore cannot satisfactorily be treated as complete and more or less isolated businesses, which is so desirable in a study of this sort.

1. Among the outstanding developments of the study is the discovery that units of labor are most productive at about the upper limit of the median group in connection with labor.

2. An inverse correlation exists between the amount of grain fed per cow and production per unit of grain.

3. The proportion of feed bought does not necessarily affect the cost of production.

4. Where forage is used efficiently, production may be increased, and cost of production decreased by the use of large amounts of forage of good quality.

5. The use of large amounts of silage increases production, but is found accompanying an increase in cost per quart caused partly or mostly by the coincidental increase in the use of grain and labor, and the substitution of silage for pasturage.

6. The price for which cows will sell provides a pretty satisfactory measure of their productive capacity.

7. Tenantry has but little effect on the business of dairying beyond the tendency for the cows in tenant herds to receive too little care, and to have too little money spent on them to force them to the point of maximum efficiency.

8. An increase in production does not necessarily imply a greater cost per unit of product and an increase obtained by a proportionate increase in the use of all factors may even result in a lower cost.

9. Cheapness of production, which accompanies greater profit depends mostly on the ability of the dairyman to use the different

factors of production in the proportions most favorable under his particular circumstances.

Some of the strongest influences on the makeup of the dairies and the systems under which they were managed, was observed to come from intangible factors which it was impossible to measure. The customs of the neighborhood, in which a dairy is located, generally exert a strong influence on its operation. The personality and psychological makeup of the dairyman is fully as potent, or perhaps more so, and as was observed above, may even predominate over his business interests and cause him to use methods which impose a loss upon the dairy where a profit is possible.

The most important item, and the factor upon which all others are conditioned, in regard to profit, which is the aim of all business dairies, is the judgment and intelligence of the dairyman and his ability to discover the limiting factors in his particular case, and those which give him especial advantages, and to organize and manage his dairy in such a way as to take the fullest advantage of them.

APPENDIX B

A List of the Dairies Composing Classes 44 to 92 Inclusive

SECTION IV

Class 44. Dairies of fewer than 20 cows which use less than 1.5 tons of forage per cow.

Herds 2, 23, 54.

Class 45. Dairies of 20 to 39 cows which use less than 1.5 tons of forage per cow.

Herds 18, 24, 26, 39, 59, 61, 64, 65, 66, 67, 68, 69, 70, 72, 73.

Class 46. Dairies of 40 or more cows which use less than 1.5 tons of forage per cow.

Herds 12, 16, 20, 21, 25, 36, 38, 40, 44, 45, 74, 76, 84, 85, 86.

Class 47. Dairies of fewer than 20 cows which use 1.5 to 1.9 tons of forage per cow.

Herds 1, 4, 50, 53, 55, 58.

Class 48. Dairies of 20 to 39 cows which use 1.5 to 1.9 tons of forage per cow.

Herds 6, 14, 17, 33, 63, 71, 87.

Class 49. Dairies of 40 or more cows which use 1.5 to 1.9 tons of forage per cow.

Herds 10, 41, 43, 46, 75, 81, 82, 83.

Class 50. Dairies of fewer than 20 cows, which use 2 or more tons of forage per cow.
Herds 3, 5, 7, 22, 28, 29, 30, 31, 32, 35, 37, 42, 47, 48, 49, 51, 52, 56, 57, 77, 78, 79.
Class 51. Dairies of 20 to 39 cows, which use 2 or more tons of forage per cow.
Herds 8, 13, 27, 34, 60, 62, 80.
Class 52. Dairies of 40 or more cows, which use 2 or more tons of forage per cow.
Herds 11, 19.

SECTION V

Class 53. Dairies of fewer than 20 cows, using no silage.
Herds 1, 2, 3, 4, 5, 7, 22, 30, 31, 32, 35, 37, 49, 52, 56, 57, 78.
Class 54. Dairies of 20 to 39 cows, using no silage.
Herds 6, 13, 15, 60, 62, 65, 66, 68, 71, 80.
Class 55. Dairies of 40 or more cows, using no silage.
Herd 76.
Class 56. Dairies of fewer than 20 cows, using less than 6 tons of silage per cow.
Herds 29, 50, 53, 54, 55, 58, 77, 79.
Class 57. Dairies of 20 to 39 cows, using less than 6 tons of silage per cow.
Herds 8, 24, 26, 33, 39, 59, 63, 64, 67, 72, 73, 87.
Class 58. Dairies of 40 or more cows, using less than 6 tons of silage per cow.
Herds 10, 20, 21, 38, 41, 45, 74, 75, 82, 83, 84, 85, 86.
Class 59. Dairies of fewer than 20 cows, using 6 or more tons of silage per cow.
Herds 23, 28, 42, 47, 48, 51.
Class 60. Dairies of 20 to 39 cows, using 6 or more tons of silage per cow.
Herds 14, 17, 18, 27, 34, 61, 69, 70.
Class 61. Dairies of 40 or more cows, using 6 or more tons of silage per cow.
Herds 11, 12, 16, 19, 25, 36, 40, 43, 44, 46, 81.

SECTION VI

Class 62. Dairies of fewer than 20 cows, cows valued at less than $75.00 per head.
Herds 2, 7, 23, 29, 30, 32, 35, 37, 42, 48, 49, 51, 52, 54, 57, 78, 79.
Class 63. Dairies of 20 to 39 cows, valued at less than $75.00 per head.
Herds 6, 59, 60, 63, 64, 65, 68, 71, 80.
Class 64. Dairies of 40 or more cows, valued at less than $75.00 per head.
Herd 76.
Class 65. Dairies of fewer than 20 cows, valued at $75.00 to $90.00 per head.
Herds, 1, 3, 4, 5, 22, 28, 31, 47, 50, 53, 55, 56.
Class 66. Dairies of 20 to 39 cows, valued at $75.00 to $90.00 per head.
Herds 8, 17, 26, 33, 39, 61, 62, 66, 69, 72, 76.
Class 67. Dairies of 40 or more cows, valued at $75.00 to $90.00 per head.
Herds 20, 21, 40, 41, 45, 74, 75, 81, 83, 84, 85.
Class 68. Dairies of fewer than 20 cows valued at $90.00 or more per head.
Herds 58, 77.

Class 69. Dairies of 20 to 39 cows, valued at $90.00 or more per head.
Herds 13, 14, 15, 18, 24, 27, 34, 67, 70, 87.
Class 70. Dairies of 40 or more cows, valued at $90.00 or more per head.
Herds 10, 11, 12, 16, 19, 25, 36, 38, 43, 44, 46, 82, 86.

SECTION VII

Class 71. Owner dairies of fewer than 20 cows.
Herds 3, 4, 22, 23, 29, 30, 31, 32, 35, 42, 47, 48, 50, 51, 52, 53, 54, 55, 56, 57, 58, 78, 79.
Class 72. Tenant dairies of fewer than 20 cows.
Herds 1, 2, 7, 15, 28, 37, 49, 77.
Class 73. Owner dairies of 20 to 39 cows.
Herds 8, 13, 14, 15, 17, 18, 24, 27, 33, 39, 59, 60, 61, 62, 63, 64, 66, 67, 69, 70, 72, 73, 80, 87.
Class 74. Tenant dairies of 20 to 39 cows.
Herds 6, 26, 34, 65, 68, 71.

SECTION VIII

Class 75. Dairies of fewer than 20 cows, producing less than 2200 quarts of milk per cow.
Herds 2, 3, 4, 5, 7, 22, 23, 30, 32, 37, 47, 48, 49, 50, 51, 52, 77, 79.
Class 76. Dairies of 20 to 39 cows, producing less than 2200 quarts of milk per cow.
Herds 6, 59, 60, 63, 65, 69, 71, 80.
Class 77. Dairies of 40 or more cows, producing less than 2200 quarts of milk per cow.
Herds 40, 74, 76.
Class 78. Dairies of fewer than 20 cows, producing 2200 to 2800 quarts of milk per cow.
Herds 28, 29, 31, 35, 54, 55, 57, 58, 78.
Class 79. Dairies of 20 to 39 cows, producing 2200 to 2800 quarts of milk per cow.
Herds 8, 13, 17, 26, 33, 39, 62, 64, 68, 72, 73.
Class 80. Dairies of 40 or more cows, producing 2200 to 2800 quarts of milk per year.
Herds 20, 21, 45, 81, 84.
Class 81. Dairies of fewer than 20 cows, producing 2800 or more quarts of milk per cow.
Herds 1, 42, 53, 56.
Class 82. Dairies of 20 to 39 cows, producing 2800 or more quarts of milk per cow.
Herds 14, 15, 18, 24, 27, 34, 61, 66, 67, 70, 87.
Class 83. Dairies of 40 or more cows, producing 2800 or more quarts of milk per cow.
Herds 10, 11, 12, 16, 19, 25, 36, 38, 41, 43, 44, 46, 75, 82, 83, 85, 86.

SECTION IX

Class 84. Dairies of fewer than 20 cows, producing milk at a cost of less than $0.050 per quart.

Herds 55, 56, 78.

Class 85. Dairies of 20 to 39 cows, producing milk at a cost of less than $0.050 per quart.

Herds 15, 18, 26, 34, 62, 64, 66, 67, 68, 70, 71, 73.

Class 86. Dairies of 40 or more cows, producing milk at a cost of less than $0.050 per quart.

Herds 10, 20, 25, 36, 41, 45, 74, 75, 76, 82, 83, 84, 85.

Class 87. Dairies of fewer than 20 cows, producing milk at a cost of $0.050 to $0.064 per quart.

Herds 1, 3, 5, 28, 31, 35, 42, 49, 54, 58, 79.

Class 88. Dairies of 20 to 39 cows producing milk at a cost of $0.050 to $0.064 per quart.

Herds 8, 13, 17, 24, 33, 60, 65, 69, 80, 87.

Class 89. Dairies of 40 or more cows, producing milk at a cost of $0.050 to $0.064 per quart.

Herds 16, 19, 38, 44, 46.

Class 90. Dairies of fewer than 20 cows, producing milk at a cost of $0.065 or more per quart.

Herds 2, 4, 7, 22, 23, 29, 30, 32, 37, 47, 48, 50, 51, 52, 53, 57, 77.

Class 91. Dairies of 20 to 39 cows, producing milk at a cost of $0.065 or more per quart.

Herds 6, 14, 27, 39, 59, 61, 63, 72.

Class 92. Dairies of 40 or more cows, producing milk at a cost of $0.065 or more per quart.

Herds 11, 12, 21, 40, 43, 81, 86.

CHANGES IN DAIRY STAFFS

M. R. TOLSTRUP
Montpelier, Vermont

WYOMING

Mr. E. F. Burton, for the last four years in charge of Dairy Extension at the University of Wyoming, has left that position to become Field Agent in Dairying for the New England States.

MASSACHUSETTS

Prof. W. P. B. Lockwood, Head of the Dairy Department, of the College, has a year's leave of absence and is doing educational work for the DeLaval Separator Company. Prof. O. A. Jamison is acting Head of the Department during Professor Lockwood's absence.

Mr. H. D. Drain, Extension Instructor in Dairying at the Agricultural College has been granted leave to enter military service.

INDIANA

Prof. R. E. Caldwell, Acting Chief of Dairy Husbandry at Purdue University, has resigned and is now Extension Specialist for the Blatchford Calf Meal Company at Waukegan, Illinois. Prof. O. E. Reed, formerly of Kansas is taking his place as Chief of the Department.

Mr. R. A. Lamson, Instructor in Dairying at Purdue University, has resigned and takes up commercial work.

GEORGIA

O. T. Goodwin, Adjutant Professor of Dairy Husbandry at the Georgia State College, has resigned that position and is now Extension Specialist at Michigan Agricultural College.

NEW HAMPSHIRE

Mr. W. R. Wilson, Associate Professor of Dairy Husbandry, has resigned to become County Agent of Grafton County, New Hampshire.

Mr. H. F. DePew, formerly assistant in Dairy Husbandry, will take up the work carried on by Professor Wilson.

VERMONT

Mr. G. F. Story, Professor of Animal and Dairy Husbandry, resigned on March 1 to become manager of the Worcester County (Massachusetts) Farm Bureau.

Mr. F. R. Churchill, Instructor in Dairying, has resigned. He is now stationed at Louisville, Kentucky, having entered the Officers' Training School for Field Artillery at Camp Zachary Taylor.

Dr. H. B. Ellenberger has been appointed to tbe Head of the Department as Professor of Animal and Dairy Husbandry and began his duties March 1.

Mr. O. M. Camburn has been appointed Extension Specialist in Dairying. Mr. Camburn was previously connected with the Dairy Division of the U. S. Department of Agriculture, in which capacity he has been in charge of all the Cow Testing Association work of this state.

NEW YORK

Mr. A. M. Beesmer, Instructor in Dairy Bacteriology, has resigned to accept a position with the California Central Creameries Company of California.

Mr. F. C. Button, Assistant, has left the Department to accept a position in commercial dairy work.

Mr. R. W. Cowan resigned to take a position as bacteriologist with a commercial dairy concern.

Mr. P. A. Downs, who is a graduate from the Connecticut Agricultural College has been appointed as Instructor in Bacteriology.

IOWA

Prof. A. W. Rudnick, formerly Professor in Dairying has been transferred to the Extension Division in Iowa with the same rank. His work consists of organizing the Iowa creameries for better production. Prof. H. F. Judkins of Storrs, Connecticut, has taken up the position vacated by Mr. Rudnick.

Mr. E. C. Ainsworth, Instructor in Dairying, enlisted for military service.

Lt. D. E. Bailey, formerly Assistant Chief in Dairy Chemistry, fell a victim to the "flu" while serving Uncle Sam as First Lieutenant in the Sanitary Corps.

MISSOURI

Prof. L. G. Rinkle, for several years in charge of the Dairy Products Section of the Dairy Husbandry Department of the University of Missouri, has resigned to accept the position of Dairy Commissioner for Kansas City. He is succeeded by Mr. W. B. Combs, who received his Master's degree from the University of Missouri in 1917, and has served one year as a member of the staff of the Dairy Husbandry Department of Rutgers College, New Jersey.

Prof. C. H. Eckles, who for many years has been in charge of the Dairy Division of the University of Missouri has resigned that position in order to take charge of the Dairy Department at the University of Minnesota, succeeding Prof. H. H. Kildee who has become Professor of Animal Husbandry at the Iowa State College.

WASHINGTON

Prof. E. G. Woodward, formerly of Nebraska, has charge of the Dairy Department of the State College.

K. B. Musser, formerly of Storrs, Connecticut, is Extension Specialist, in Dairy Husbandry.

SOUTH DAKOTA

Prof. C. Larsen, while still Head of the Dairy Husbandry Department, has been made Director of Extension Service also. The work in the Dairy Department is largely left in charge of Prof. T. Wright for the manufacturing and Professor Wylie for the production part.

ARKANSAS

Prof. F. H. Herzer, in charge of Dairy Manufacturing at Fayetteville, Arkansas, has enlisted in the Naval Aviation Corps. He is succeeded by Mr. R. H. Mason, formerly with U. S. Department of Agriculture, Dairy Division as Field Man for North Carolina.

OREGON

L. M. Wing, Instructor in Dairy Husbandry at the Oregon Agricultural College, has been granted leave and is in the Aviation Service. Mr. Solomon Fine of Rhode Island and Missouri has taken up the work vacated by Mr. Wing.

Mr. H. R. Taylor has left his position as assistant in Dairy Husbandry and is now Superintendent of the John Jacob Astor Experiment Station for development of dairying on tide land at Astoria, Oregon.